FITCHBURG COMMUTER RAIL LINE SERVICE EXPANSION STUDY

Submitted to:

Massachusetts Bay Transportation Authority

February 2005

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TRANSPORTATION ENGINEERS & PLANNERS
RESPONSIVE
TRANSPORTATION
SOLUTIONS

In Association with
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EXECUTIVE SUMMARY

McMahon Associates has completed a study of potential service improvements along the Fitchburg Branch. This study has examined three alternative improvement strategies, evaluated the potential ridership benefits of each alternative, and determined the capital investment and operating cost requirements of each alternative. The project approach and findings are summarized below:

1. IDENTIFICATION OF GOALS AND OBJECTIVES

Goals and objectives for the Fitchburg Commuter Rail Line Service Expansion Study were based on meetings with public officials and concerned parties, including, but not limited to, the MBTA, local transit agencies, civic leaders, and commuters. Key concerns expressed over the course of the meetings were categorized according to a proposed implementation time frame. In sequence, a short-term goal refers to actions that could be taken within five years, a mid-term goal would be done within five to ten years, and a long-term goal would be expected to take 10 or ore years to complete.

2. EXISTING CONDITIONS

The Fitchburg Line serves approximately 19 percent of the total commuter rail passenger volume on the north side of Boston. The ridership levels on the Fitchburg Line are affected by service levels and parking capacity, which are lower than that available on the other lines. Certain notable characteristics of the Line's infrastructure, ridership, and service are:

- MBTA's longest commuter rail line
- Highest number of zone 8 stations
- Highest number of stations
- Highest average AM peak travel time
- Least number of parking spaces
- Lowest daily passenger boardings of any terminus station (Fitchburg)

3. SUMMARY OF IMPROVEMENT CONCEPTS AND CONSTRAINTS

The goals identified in Task 1, in combination with the Existing Conditions analysis developed in Task 2, provide the framework for identifying and analyzing potential improvement concepts and associated constraints in this Fitchburg Commuter Rail Line Service Expansion Study. These improvement concepts and constraints encompass a range of items, such as operations, rolling stock, track condition, physical feasibility, coordination with freight activities, frequency of grade crossings, availability of commuter parking, and community plans and ordinances. Moreover, there is a time dimension to addressing many of the items. Therefore, the discussion of improvement concepts and constraints is structured around the study goals and three implementation time frames: short-range, mid-range, and long-range.

The five broad goals for the Fitchburg Commuter Rail Line are:

- Improve travel time
- Improve passenger comfort
- Improve service reliability
- Meet ridership demands
- Improve overall quality of service

The following table summarizes the potential concepts for improvement.

SHORT-RANGE	Consolidate stations
	Eliminate/reduce flag stops
	Increase travel speeds
	Eliminate delays at Porter Square
	Reduce length of crew changeover at Fitchburg
	Add sheltered seating
	Improve station lighting
	Provide bicycle storage
	Monitor system reliability
	Improve track conditions
	Schedule improvements
	Pass/Ticket sales
	“Write to the top” and pricing policies
MEDIUM-RANGE	Expedite boarding/alighting
	Reset grade crossing setbacks
	Signal system improvements
	Indoor waiting facilities
	Other infrastructure improvements
	Initiate reverse commute
	Gardner van/bus shuttle
	Station improvements
	Real-time information
LONG-RANGE	Double track
	Additional service
	Increased seating
	Line extension: Wachusett/Gardner
	Expand reverse commute
	Regional parking

4. FUTURE CONDITIONS

Three alternative improvement packages were developed based on the implementation period of short-range, medium-range, and long-range for detailed analysis and evaluation. A comparative matrix evaluating each of the improvement concepts suggested was created. The analysis is based on the suggested improvements performance in terms of utilization, mobility, cost-effectiveness, air quality, service quality, economic impacts, land use impacts, and environmental justice as outlined as analysis criteria in the "Program for Mass Transit".

5. ANALYSIS AND EVALUATION OF OPTIONS

The Evaluation Matrix provides an analytical framework for evaluating alternate improvements. In general, improvement concepts were ranked +1 for positive benefits, 0 for negligible benefits, and -1 for negative impacts. The ranks assigned to each alternative were summed to determine if the overall benefits outweighed the negative impacts. The most beneficial alternatives generally had an overall/or summary score of +2 or better. Scores of +1 or below were generally not considered for implementation. Actual ridership and parking demand forecasts for three forecast years were then estimated by CTPS.

6. RECOMMENDATIONS

Improvement packages for the Fitchburg Line have been defined for implementation in the short-range, medium-range and long-range.

The short-range (implemented within the next five years) improvement package includes:

- consolidation of stations,
- schedule improvements,
- addition of continuously welded track, and
- design of signal system upgrades.

The medium-range (implemented within 5 – 10 years) improvement package includes:

- station improvements,
- initiation of reverse commute options, and
- signal system improvements.

The long-range (implementation expected to take 10 or more years) improvement package includes:

- the creation of a regional parking facility,
- additional peak/off peak service,
- double tracking, and
- extension of service to Wachusett and Gardner.

INTRODUCTION

In an effort to better understand its options for improving its commuter rail service on the Fitchburg Line, the MBTA initiated this Fitchburg Commuter Rail Line Service Expansion Study. The purpose of this study is to evaluate service comments and recommend service adjustments where necessary.

Commuter rail service from Gardner to Boston on the Fitchburg Line was implemented in January 1980. The net cost of the service was paid fifty percent by the federal government and fifty percent by the Commonwealth. Commuter rail service on the Fitchburg Line to North Station in Boston consisted of sixty round trips weekly. In June 1983, there were fifty-four weekly round trips, with the net cost of the service being paid entirely by the Commonwealth. The service to Gardner was cut back late in 1983, and discontinued at the end of June 1984. At that juncture Fitchburg became the western terminus of this line.

Today, the MBTA operates 35 daily trips on the Fitchburg/South Acton Line, 25 of which serve the Fitchburg terminus. The commuter rail fare is based on a zone fare system, with a one way fare from Fitchburg to Boston costing $6.00. Elderly, disabled, and children are charged half fare.

Guilford Transportation Industries (GTI), through the Springfield Terminal Railway (STR), operates a rail freight line from Boston to Mechanicville, New York. Within the study region, it runs east-west from Ayer to Athol by way of the Fitchburg Main Line and Freight Main Line. The Fitchburg Main Line and Freight Main Line, between Boston and Fitchburg, are owned by the MBTA. Permission by the MBTA has been granted for the STR to transport freight over these tracks. West of Fitchburg, the line is owned by the Vermont and Massachusetts (V&M) Railroad, and operated by the STR.

The MBTA initiated this study of potential service improvements along the Fitchburg Branch in response to comments received in the 2001 public forums held to update the Program for Mass Transit. This study has examined three alternative improvement strategies, evaluated the potential ridership benefits of each alternative, and determined the capital investment and operating cost requirements of each alternative.

TASK 1: GOALS AND OBJECTIVES

The goals and objectives statement below is structured according to a proposed implementation time frame. In sequence, a short-term time frame refers to actions that could be taken immediately or within five years. A mid-term action could be done within five to ten years. Long-term actions are expected to take 10 or more years to complete. As a set of goals and objectives for study, the list below is a set of actions which will be examined for action in the short, medium and long range. Each action was presented for inclusion in the study by the public at the meetings that were held between March and May of 2003.

SHORT TERM

To improve travel time and passenger comfort:

- Track work to provide continuously welded rail, for approximately 7.5 miles, between Fitchburg and South Acton.
- Express service from South Acton to North Station with one additional morning train.
- Express service from North Station to Acton with one additional evening train.
- Review and analyze the potential for consolidation of stations.
- Investigate outbound delays at Porter Square caused by Red Line service delays.
- Investigate the switching of conductors and the delays this causes at Fitchburg.

To improve service availability and better meet passenger and ridership demands:

- Revise service schedule to provide earlier morning service from Fitchburg to North Station.
- Revise service schedule to provide outbound midday service from North Station to Fitchburg.
- Identify a location for a regional station and parking facility to serve Route 2 at I-495.
- Initiate feeder bus service between Gardner and Fitchburg/North Leominster stations via the greater Wachusett area.
- Develop a detailed transportation plan to reinstitute a transit link between Gardener and Fitchburg.
- Reassign additional rolling stock as needed to meet demand.

To improve the overall quality of service to the passengers:

- Improve the consistency and accuracy of LED sign information transmitted to each station.
- Maintain consistent platform assignments by time of day for outbound service from North Station.
- Improve station shelters and available services (increase sheltered seating).
- Improve station maintenance.
- Investigate revenue losses from lax collections.
- Install bike racks at stations needing them.

MID TERM

To improve travel time and passenger comfort:

- Revise schedule to compensate for station consolidation.

To improve service availability and better meet passenger and ridership demands:

- Rehabilitate the existing signal system on the line.
- Identify parking improvements at Devens and South Acton.
- Identify opportunities for adding at-grade parking spaces at existing stations.
- Develop and initiate reverse commute service.

To improve the overall quality of service to the passengers:

- Investigate the feasibility of peak and off-peak pricing.
- Identify opportunities for satellite shuttles from employee parking to station.

LONG TERM

To improve travel time and passenger comfort:

- Complete double tracking the entire branch between Fitchburg and North Station.
- Upgrade equipment/rolling stock.

To improve service availability and better meet passenger and ridership demands:

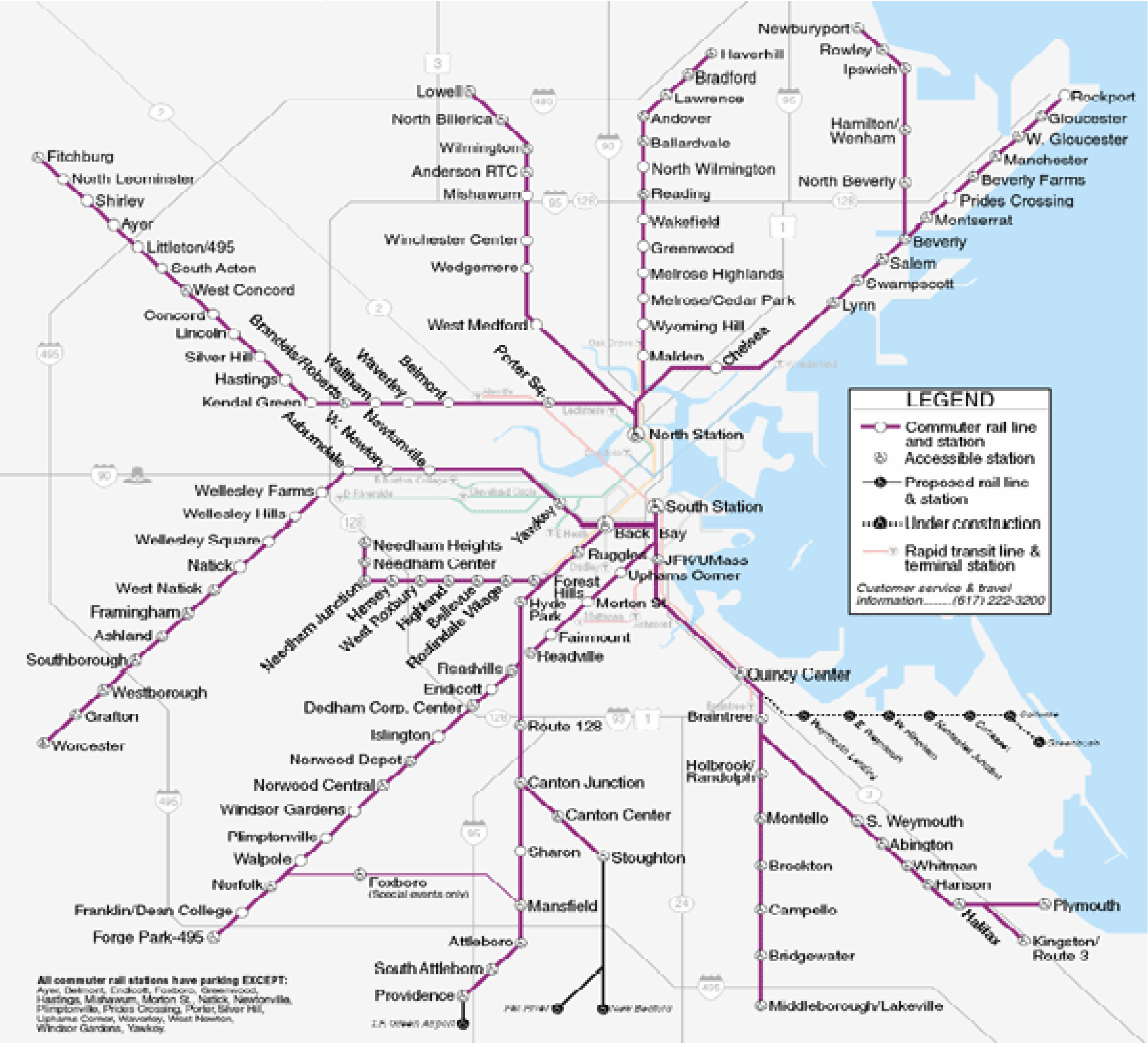
- Reinstitute commuter rail service between Gardner and Fitchburg via Wachusett Station.
- Improve service frequency - to level commensurate with other lines.
- Extend service from Fitchburg to the greater Gardner region.

TASK 2: EXISTING CONDITIONS

The commuter rail system in Boston began in the mid-1830s. At that time, the Boston & Worcester, Boston & Providence and Boston & Lowell, were the only three railroads that accessed Boston from outlying regions. Over many decades the system has adapted to the employment and housing patterns of its riders and expanded with the addition of other railroad lines. In the 1970s, the Massachusetts Bay Transportation Authority (MBTA) incrementally became owner of the commuter rail system.

Currently, the MBTA operates 13 commuter rail lines running to and from both North Station and South Station on over 1,300 miles of track. The entire system has a total of 123 stations servicing over 140,800 passengers per weekday. Figure 2.1 is a schematic of the existing system.

Figure 2.1: MBTA Commuter Rail System



All commuter rail stations have parking EXCEPT:
Ayer, Belmont, Endicott, Foxboro, Greenwood, Hastings, Mishawum, Morton St., Natick, Newtonville, Plimptonville, Prides Crossing, Porter, Silver Hill, Uphams Corner, Waverley, West Newton, Windsor Gardens, Yawkey.

MBTA commuter rail ridership has increased by 400% over the past 25 years, with the stations most distant from Boston experiencing the highest growth rate. This is consistent with regional settlement patterns, which have seen substantial residential growth in communities beyond Route 128. To accommodate this continued strong demand, the MBTA has been actively pursuing construction of new or extended rail lines. Guided by the Program for Mass Transportation (PMT), the system has seen service and infrastructure expansion along the Framingham-Worcester Line to the west, Old Colony Line to the south, and the Rockport/Newburyport lines to the north. As part of a continuing effort to improve service for its customers, the MBTA is now exploring the operational and capital needs of the Fitchburg Line.

FITCHBURG LINE PROFILE

The Fitchburg Line serves approximately 19 percent of the total number of commuter rail passenger volume on the north side of Boston. As discussed more fully later in this chapter, the ridership levels are affected by service constraints on the Fitchburg Line as compared to the available services on other lines. For example, the outlying commuter rail stations on the other three North Station lines (Rockport/Newburyport, Haverhill and Lowell) all experience higher ridership, which may be due to increased service reliability, higher average speeds and greater parking capacity on these lines.

Certain notable characteristics of the Fitchburg Commuter Rail Line related to infrastructure, ridership, and service are:

Longest Commuter Rail Line

Of all the MBTA commuter rail lines, including all branches, serving North and South Stations, the Fitchburg Line is the longest at 49.5 miles. The next longest are the Worcester Line at 44.3 miles and the Attleboro/Providence Line at 43.2 miles.

Highest Number of Zone 8 Stations of All Lines

The Fitchburg Line has four Zone 8 stations, Fitchburg, North Leominster, Shirley, and Ayer. The only other line with more than one Zone 8 station is the Worcester Line with two Zone 8 stations, Worcester and Grafton. The other Zone 8 stations in the MBTA commuter rail network are: Rockport, Newburyport, Plymouth, Kingston, Middleboro, and Providence. Consequently, Fitchburg Line passengers in this zone travel the longest distances and thus pay the highest fares for the service.

Highest Number of Stations

The Fitchburg Line has more stations than any other MBTA commuter rail line. There are 17 stations along the line, excluding North Station. The Worcester Line, the next highest, has 16 stations, followed by the Franklin/ Forge Park Line at 15 stations.

Highest Average AM Peak Travel Time

The Fitchburg Line has the longest scheduled average AM peak travel time at 1:26. The next highest are the Worcester Line at 1:20 and the Providence Line at 1:11.

Least Number of Parking Spaces

Only the Fairmount Line, a short line located entirely within the City of Boston, has fewer parking spaces than the Fitchburg Line. According to information posted on the MBTA website, the Fitchburg Line presently has 1,049 parking spaces at thirteen of the seventeen existing stations.

Lowest Daily Passenger Boardings of any Line Terminus

Typical daily passenger boardings at Fitchburg are 209. This appears to be directly related to the limited parking at Fitchburg, with only 67 spaces. A 400 space commuter parking garage is currently under construction in Fitchburg and another 130 space parking lot has recently been completed at the North Leominster Station.

Fewer Trains per Day

Next to the Worcester Line with twenty (20) trains per day, the Fitchburg Line has the fewest trains per day at twenty five (25) trains. Fitchburg has five AM peak trains and only four PM peak trains.

These characteristics and other existing conditions are examined in more detail in the sections that follow: Physical Characteristics of the Line, Ridership, and Service. Tables are presented that summarize statistical information for the Fitchburg Line along with tables showing comparative statistics for other MBTA Commuter Rail Lines.

PHYSICAL CHARACTERISTICS OF THE MBTA FITCHBURG COMMUTER RAIL LINE

Table 2.1 provides information on the Fitchburg Commuter Rail Line by station including miles to North Station, number of station stops, average peak AM minutes to North Station, average peak speed to North Station, number of parking spaces and daily boardings. Table 2.2 on the following page provides comparable information for all MBTA Commuter Rail Lines.

As shown in Table 2.1, Fitchburg, the terminus of the Fitchburg Commuter Rail Line is located 49.5 miles from North Station. There are 25 trains serving Fitchburg daily. South Acton Station, at a distance of 25.3 miles from North Station, is served by 35 trains daily. All trains go to South Acton and ten additional trains go to Fitchburg at the end of the line. South Acton is an important station as it has the highest number of parking spaces and has one of the highest number of boardings on the line. There are a total of 17 stations on the line excluding North Station. There are three stations in the Town of Weston: Silver Hill, Hastings, and Kendal Green, located within 1.5 miles of each other. There are two stations in the Town of Belmont: Waverley and Belmont, within 1.0 mile of each other. The average AM peak time from Fitchburg to North Station is 1:26, from South Acton to North Station 0:49. The average AM peak speed from Fitchburg to North Station is 34.5 mph.

Currently, there are 67 parking spaces in Fitchburg and 1,049 spaces along the line. A parking garage is under construction at Fitchburg adding 400 spaces and a parking lot in North Leominster was just recently completed, adding 130 spaces. The new parking will bring the total parking spaces on the line to 1,579. Parking demand exceeds available supply, and parking utilization has been observed at or near 100% along the line. The projected unconstrained demand for parking on the Fitchburg Line for 2010 is estimated at 2,295 to 2,890 spaces.[1]

Table 2.1
MBTA Fitchburg Line Characteristics by Station

Station	Miles to North Station	Number of Daily Trains		Average AM Peak Minutes to North Station	Average AM Peak Speed to North Station	Parking Spaces at Station[2]	Recent Daily Inbound Boardings[3]
		Designated Stops	Flag Stops				
Fitchburg	49.5	25	0	86	34.5	67	209
N. Leominster	45.3	25	0	80	34.0	49	208
Shirley	39.4	18	7	72	32.8	25	151
Ayer	33.5	24	1	66	30.5	30	228
Littleton/Rt. 495	30.1	15	10	57	31.7	15	146
South Acton	25.3	35	0	49	31.0	287	466
West Concord	21.9	28	4	46	28.6	146	445
Concord	20.0	32	1	42	28.6	86	439
Lincoln	16.7	20	12	36	27.8	161	284
Silver Hill	14.7	5	0	36	24.5	0	19
Hastings	13.7	4	9	33	24.9	6	34
Kendal Green	13.2	14	15	31	25.5	57	106
Brandeis/Roberts	11.5	30	1	28	24.6	70	434
Waltham	9.9	33	0	23	25.8	50	521
Waverley	7.4	8	13	19	23.4	0	127
Belmont	6.4	9	17	17	22.6	0	131
Porter Square	3.4	35	0	11	18.5	0	165
					Totals	1,049	4,113

Table 2.2 provides statistics on all MBTA Commuter Rail lines, and enables a comparison of Fitchburg with other MBTA Commuter Rail Lines. The Fitchburg Line is the longest MBTA Commuter Rail Line at 49.5 miles. The next longest is Worcester at 44.3 miles and Providence at 43.6 miles. Fitchburg has the highest number of stations at seventeen (17). Worcester has sixteen (16) and Franklin/Forge Park has fifteen (15). The average AM peak travel time from Fitchburg to North Station is also the longest at 1:26. From Worcester, the AM peak travel time is 1:20 and from Providence 1:11. The AM peak speed from Fitchburg to North Station is about average, at 33.4 mph. The Middleboro Line is the fastest at 37.5 mph, followed by Providence 36.8 mph, and Kingston 35.7 mph. The number of parking spaces along the Fitchburg Line (1,049 spaces) is extremely low compared with other lines. Only the Fairmount Line, located completely within the City of Boston, has fewer spaces. The Providence Line has 6,499 spaces, the Middleboro Line has 5,036 spaces and the Kingston Line has 5,161 spaces (all of these lines are on the South Side).

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[1] Commuter Rail and Rapid Transit Parking and Ridership Demand Forecasts, CTPS, January 2002.
[2] http://www.mbta.com
[3] Ridership and Service Statistics, MBTA, 2002. February 2001 Boardings.

Table 2.2
MBTA Commuter Rail Line System wide Characteristics by Line

	Line	Miles to Boston	Intermediate Stations[1]	Average AM Peak Minutes to Boston	Average AM Peak Speed to Boston	Parking Spaces Along Line[2]	Year 2000 Population of Terminus[3]	Typical Daily Boardings for Line[4]
North Side	Fitchburg	49.5	17	1:29	33.4	1,049	39,102	4,113
	Newburyport	36.3	11	1:05	33.5	3,170	17,189	8,278
	Rockport	35.3	13	1:09	30.7	2,020	7,767	
	Haverhill	32.9	13	1:05	30.4	1,533	58.969	4,970
	Lowell	25.5	7	0:48	31.9	2,910	105,167	4,980
South Side	Worcester	44.3	16	1:20	33.2	2,964	172,648	8,247
	Needham	13.7	11	0:42	19.6	1,399	28,911	4,832
	Forge Park-495	30.8	15	1:02	29.8	3,854	29,560	9,071
	Attle/Providence	43.6	10	1:11	36.8	6,499	173,618	10,279
	Stoughton	18.8	7	0:38	29.7	4,146	27,149	1,728
	Fairmount	7.7	4	0:23	20.1	381	N/A	1,270
	Middleboro	35.6	9	0:57	37.5	5,036	19.941	3,615
	Plymouth	35.6	9	N/A	N/A	4,228	51,701	3,802
	Kingston	35.1	9	0:59	35.7	5,161	11,780	

1. Excludes North or South Station
2. Excludes North or South Station
3. From 2000 U.S. Census
4. From "Ridership and Service Statistics 2002". Boardings for Newburyport and Rockport are combined, also boardings for Plymouth and Kingston are combined

Another characteristic of the Fitchburg Line is the high number of stations in the outer zones. Table 2.3 summarizes the number of stations by zone for all MBTA Commuter Rail Lines.

As previously stated, the Fitchburg Line has the highest number of Zone 8 stations of all MBTA Commuter Rail Lines. The Fitchburg Line has four stations in Zone 8: Fitchburg, North Leominster, Shirley, and Ayer. The only other line with more than one Zone 8 station is the Worcester Line with two Zone 8 stations, Worcester and Grafton. The other Zone 8 stations in the system are Rockport, Newburyport, Plymouth, Kingston, Middleboro and Providence. Consequently, those Fitchburg Line passengers in Zone 8 travel the longest distances and thus pay the highest fares.

Table 2.3
MBTA Commuter Rail Line System-wide Stations by Zone

	Line	Number of Stations by Zone										
		1A	1B	1	2	3	4	5	6	7	8	Total
North Side	Fitchburg	0	1	2	2	3	1	2	1	1	4	17
	Newburyport	0	1	0	2	2	1	2	1	1	1	11
	Rockport	0	1	0	2	2	2	2	1	2	1	13
	Haverhill	0	1	3	3	1	1	1	1	2	0	13
	Lowell	0	1	2	2	1	0	1	1	0	0	8
South Side	Worcester	2	0	1	1	4	2	1	2	1	2	16
	Needham	2	1	4	4	0	0	0	0	0	0	11
	Forge Park-495	2	0	1	3	3	3	2	1	0	0	15
	Attle/Providence	2	0	1	1	1	1	0	1	2	1	10
	Stoughton	2	0	1	1	2	1	0	0	0	0	7
	Fairmount	1	1	1	1	0	0	0	0	0	0	4
	Middleboro	1	0	1	1	1	2	1	1	0	1	9
	Plymouth	1	0	1	1	1	1	1	1	1	1	9
	Kingston	1	0	1	1	1	1	1	1	1	1	9

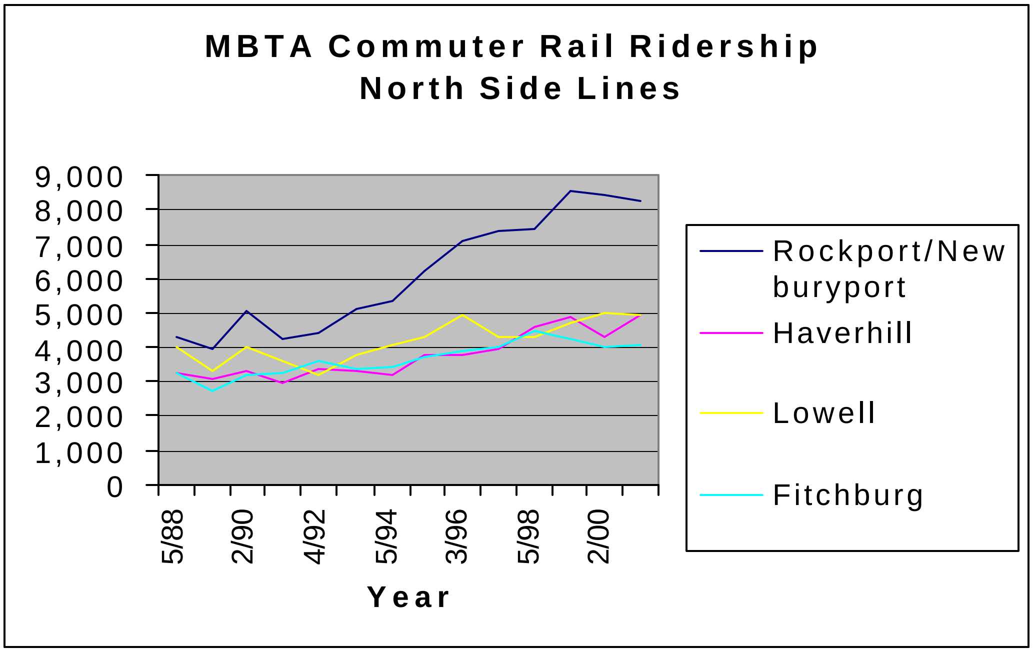
Another issue is the availability of double-track segments on the line. In fact, single-track sections may emerge as the most significant constraint to service expansion in the future. Generally, the line runs in a north/south direction between the South Acton and Ayer Commuter Rail Stations, and double tracks currently exist only on the southern side of the South Acton Commuter Rail Station. The double tracks merge to a single track before entering the South Acton Station, and continue north as a single track until entering the Town of Ayer.

RIDERSHIP ON THE FITCHBURG LINE

Typical daily boardings (Monday through Friday) on the Fitchburg Line are 4,113 passengers. Total daily system wide boardings on the MBTA Commuter Rail are 65,185 including 22,341 on the North Side and 42,844 on the South Side. This data was derived from the MBTA publication Ridership and Service Statistics 2002. Thus, Fitchburg ridership makes up 18.4% of North Side ridership and 6.3% of the ridership system wide.

There are several indicators that ridership on the Fitchburg Line is growing. Figure 2.2 shows the daily annual boardings over a fourteen year period for the North Side Lines.

Figure 2.2



During the period from May 1988 through February 2001, ridership on the Fitchburg Line grew by 28%. For the same period, ridership on the Rockport/Newburyport line grew by 91%, Haverhill by 53%, and Lowell by 24%. Significant investment has been made in the Rockport/Newburyport Line during this time with the opening of the Newburyport branch including the construction of new stations and parking facilities. The data used in the graph represents the combined ridership of Newburyport and Rockport (for the purposes of this analysis, these two branches should be considered as two lines). In addition, parking has been expanded on the Lowell Line.

Several factors are constraining growth on the Fitchburg Line. Referring back to Tables 2.1 and 2.2, long commuting times from Fitchburg to Boston, parking limitations, and lack of double-tracks have an adverse effect on growth. Another factor that must be considered is the total number of trains to Fitchburg (this will be discussed in more detail in the next section, on service characteristics):

Line	Total Daily Trains
Fitchburg	25
Newburyport	24
Rockport	24
Haverhill	26
Lowell	42

Despite the constraints on growth, ridership on the Fitchburg Line continues to increase. Projected inbound boardings are expected to grow from the current estimated 4,000, to either

5,000 under constrained parking conditions or 6,500 under unconstrained conditions, for the year 2010.[1]

Table 2.4
MBTA Commuter Rail Boardings and Parking at Terminus

	Line	Typical Daily Boardings at Terminus[2]	Parking Spaces At Terminus[3]
North Side	Fitchburg	209	67
	Newburyport	674	801
	Rockport	215	88
	Haverhill	355	159
	Lowell	1,292	695
South Side	Worcester	781	457
	Needham	460	243
	Forge Park-495	1,322	716
	Attle/Providence	1,013	330
	Stoughton	1,110	457
	Fairmount	411	354
	Middleboro	801	853
	Plymouth	42	96
	Kingston	890	1,029

From Table 2.4, boardings at Fitchburg station are the lowest of any terminus throughout the MBTA Commuter Rail System at 209, except for Plymouth, which has very limited service. Rockport is the next lowest at 215 boardings. Parking at Fitchburg and Rockport are also the lowest. Stations such as Newburyport, Lowell, Forge Park-495, Middleboro, and Kingston that have high passenger boardings also have a large number of parking spaces. The data suggests that boardings are related to parking in addition to other criteria including passenger demand, station location, and service frequency.

Another point of interest with regard to ridership is that 23% (942) of the boardings on the Fitchburg Line are west of South Acton. Passengers who board west of South Acton have twenty-two trains available, compared with passengers east of South Acton who have thirty-two.

SERVICE CHARACTERISTICS

Service on the Fitchburg Line is compared with the other MBTA Commuter Rail Lines in Table 2.5.

From Table 2.5, it can be seen that the number of trains to Fitchburg, twenty five (25) trains per day is less than all other lines except for Worcester at twenty (20) trains per day (there are thirty (30) trains serving the combined Kingston and Plymouth branches). As mentioned in the Ridership section, the other North Side Lines have between 24 and 42 trains to the terminal point.

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[1] Commuter Rail and Rapid Transit Parking and Ridership Demand Forecasts, CTPS, January 2002.
[2] Ridership and Service Statistics, MBTA, 2002.
[3] http://www.mbta.com

Table 2.5
Trains per Weekday by Time of Day

	Line	Miles to Boston	Total Trains	Total		AM Peak[1]		Midday[2]		PM Peak[3]		Evening[4]	
				In	Out	In	Out	In	Out	In	Out	In	Out
North Side	Fitchburg	49.5	25	13	12	5	1	3	3	1	4	4	4
	Newburyport	36.3	24	12	12	5	2	4	4	2	4	1	2
	Rockport	35.3	24	12	12	4	2	4	3	2	4	2	3
	Haverhill	32.9	26	13	13	5	2	4	3	2	5	2	3
	Lowell	25.5	42	21	21	5	4	8	7	3	5	5	5
South Side	Worcester	44.3	20	10	10	4	1	3	2	1	4	2	3
	Needham	13.7	32	16	16	4	3	5	4	3	5	4	4
	Forge Park/I-495	30.8	30	16	14	6	2	4	4	2	4	4	4
	Attle/Providence	43.2	23	12	11	4	2	4	3	1	4	3	2
	Stoughton	18.8	30	15	15	3	5	5	3	1	4	6	3
	Fairmount	7.7	43	22	21	6	5	7	7	5	6	4	3
	Middleboro	35.6	24	12	12	4	2	4	4	2	4	2	2
	Plymouth	35.6	8	4	4	0	1	3	3	1	0	0	0
	Kingston	35.1	22	11	11	4	1	3	3	1	4	3	3

1. Arrives or departs Boston before 9:00 AM
2. Arrives or departs Boston between 9:00 AM and 4:00 PM
3. Arrives or departs Boston between 4:00 PM and 7:00 PM
4. Arrives or departs Boston after 7:00 PM

During the morning peak, there are five trains from Fitchburg to North Station, which is comparable to other lines. However, the first train leaving Fitchburg at 5:45 AM arrives North Station at 7:12 AM. This is significantly later than other North Side Lines:

Line	AM Peak Inbound Train Arriving North Station
Fitchburg	7:12 AM
Rockport	6:16 AM
Newburyport	6:32 AM
Haverhill	6:33 AM
Lowell	6:22 AM

A new proposed schedule could address this problem, with the addition of a 5:05 AM train from Fitchburg scheduled for arrival at North Station at 6:30 AM.

During the afternoon peak, from 4:00 PM – 7:00 PM, there are four trains leaving North Station to Fitchburg: 4:40 PM, 4:50 PM, 5:20 PM and 6:15 PM. Four trains also depart North Station to Newburyport and to Rockport during the afternoon peak, while Haverhill has five and Lowell has six peak trains. Following the 6:15 PM train to Fitchburg, the next outbound train leaves North Station at 7:35 PM, a gap of 1:20.

The first outbound train leaves North Station at 8:55 AM arriving Fitchburg at 10:15 AM. The other North Side Lines have trains arriving earlier.

Line	Arrival of First AM Outbound Train Leaving North Station
Fitchburg	10:15 AM
Rockport	8:49 AM
Haverhill	8:18 AM
Newburyport	7:29 AM
Lowell	6:29 AM

During off peak times, there are a few large gaps in the service to Fitchburg. Inbound, there are gaps in service from Fitchburg to North Station between 7:20 AM and 10:27 AM and from 3:05 PM and 6:12 PM. Outbound, there is a significant gap from North Station to Fitchburg from 1:20 PM and 4:40 PM (three hours and twenty minutes).

Operations may also be affected by the large number of grade crossings along the line. Between the Acton Commuter Rail Station and the Boxborough town line, the Fitchburg Commuter Rail Line has three at-grade crossings. The crossings within the Town of Acton occur on Martin Street and twice on Central Street (one west of Route 111 and one east of Route 111). Within the Towns of Boxborough and Littleton, the Fitchburg Commuter Rail Line has two at-grade crossings, which occur on Littlefield Road in Boxborough and on King Street in Littleton. Preliminary field investigations found the width of the existing rail beds sufficient to accommodate a double track at all at-grade crossings between South Acton and Ayer, and, therefore, the width of the rail should not be considered a constraint.

In summary, the major issues in peak service are the lack of an early train from Fitchburg that arrives before 6:30 AM, the lack of a PM peak train around 6:50 PM – 7:00 PM. Related to the PM peak train is the need for an outbound train mid to late afternoon, between 3:30 PM – 4:00 PM that goes all the way to Fitchburg.

FREIGHT

The Guilford Rail System, through its Springfield Terminal Railway (STR), operates freight service over its main line from Mattawamkeag, ME to Rotterdam Junction, NY. This freight rail service overlaps with MBTA commuter rail service from Boston to Fitchburg. Although the lines between Boston and Fitchburg are owned by the MBTA, an easement has been granted giving STR the rights to operate freight service over these lines. STR dispatches both the freight and passenger service operating between Ayer and Fitchburg. The MBTA dispatches the freight and passenger service between Ayer and Boston. A map of the present Guilford Rail System is attached in Appendix A.

In the past, Guilford's predecessor, the Boston and Main Railroad (B&M), owned and operated both freight service from Mattawamkeag to Rotterdam Junction and passenger service from Boston to Gardner. In 1976, the B&M sold the passenger service and the infrastructure to the MBTA, yet continued to operate the passenger service under contract to the MBTA. Under the terms of the sale, the B&M was granted an easement so that its right to operate freight service could continue. In 1986, the B&M no longer operated passenger service for the MBTA. Guilford acquired the B&M and the easement was transferred to Guilford Rail System and its STR. Now, freight and passenger service between Boston and Ayer is dispatched by the Massachusetts Bay Commuter Railroad Company (MBCR), the private operator for the MBTA, and by STR from Ayer to Fitchburg. Freight service on the railroad is scheduled around passenger service, with passenger service given priority.

Over the lines shared by both the MBTA and STR, freight activity is particularly strong between Ayer and Fitchburg. There are five daily eastbound and five westbound "through trains" (long distance freight trains) at Ayer. In addition, there are several regular local trains operating from Ayer and Fitchburg. The number of these trains is varied and is driven by customer demand. Coordination of the freight and passenger movements can be complicated. Although the scheduling of freight service is more flexible than the scheduling of passenger service, regular freight service may vary as much as twelve hours from plan. Potentially all freight trains, even those planned to operate in the off-hours of commuter rail, could conflict the passenger service. In addition, since freight service is driven by demand, freight service could increase with a boost in the economy.

An increase in freight movements is, however, manageable. At the current level of freight activity, freight service is rarely impacted by passenger service. An increase in the number of rail sidings at key locations would, however, serve to improve the current situation as well as facilitate future expansion of both freight and passenger service. Another improvement that would benefit service operations along the Fitchburg Commuter Rail Line would be to provide automatic interlocking at Ayer. Currently, track crossings in Ayer are accomplished by manual throws, which are slow and antiquated. An additional improvement opportunity is to provide a crossover between the tracks in Shirley. The addition of a crossover would create more options for both freight and passenger trains clearing the tracks.

DEMOGRAPHIC CHARACTERISTICS

Population change in communities served by the Fitchburg Line is presented in Table 2.6. Taken as a whole, from 1990 to 2000, there has been modest growth in cities and towns served by the line. The main population centers of Fitchburg and Leominster have been stable for the ten-year period, with a combined increase in population of just over 1,000. Boxborough and Littleton had the largest percentage growth in population at 46% and 16%, respectively, but in absolute numbers, this is an increase of about 2,700. By comparison, the region's growth rate from 1990 to 2000 was 4.9%.

Table 2.6
Population Change for Fitchburg Line Communities: 1990 to 2000

City/Town	1990	2000	% Change
Acton	17,872	20,331	13.8
Ayer	6,871	7,287	6.1
Belmont	24,720	24,194	-2.1
Boxborough	3,343	4,868	45.6
Cambridge	95,802	101,355	5.8
Concord	17,076	16,993	-0.5
Fitchburg	41,194	39,102	-5.1
Leominster	38,145	41,303	8.3
Lincoln	7,666	8,056	5.1
Littleton	7,051	8,184	16.1
Lunenburg	9,117	9,401	3.1
Shirley	6,118	6,373	4.2
Waltham	57,878	59,226	2.3
Weston	10,200	11,464	12.4
TOTAL	343,053	358,137	12.79

TASK 3: SUMMARY OF IMPROVEMENT CONCEPTS AND CONSTRAINTS

A wide range of improvements have been discussed for the Fitchburg Commuter Rail Line including, but not limited to, more peak/reverse peak service, express trains to and from North Station, line extensions to the greater Gardner region, expansion of the existing/development of new commuter parking facilities, and double tracking of the line where needed. These, and other improvements, need to be evaluated in relation to the overall goals of the study. In addition, the feasibility or difficulty of implementing a specific improvement must also be considered. This task reviews both the prospects for improving service in the corridor, as well as the factors that may tend to limit the MBTA's ability to implement improvements.

The Goals previously identified in Task 1, in combination with the Existing Conditions analysis developed in Task 2, provide the framework for identifying and analyzing the potential concepts for improvement and associated constraints that may be available to the MBTA. These improvement concepts and constraints encompass a range of items, such as operations, rolling stock, track condition, physical feasibility, coordination with freight activities, frequency of grade crossings, availability of commuter parking and community plans and ordinances. Moreover, there is a time dimension to many of the items. For example, in some situations, operational changes may be implemented fairly easily, say within six months. But in the case of rolling stock, the lead-time for purchasing new equipment may be years. Therefore, the following discussion has been structured not only around the goals but also around general time frames.

The five broad goals for the Fitchburg Commuter Rail Line are:

- Improve Travel Time
- Improve Passenger Comfort
- Improve Service Reliability
- Meet Ridership Demands
- Improve Overall Quality of Service

The following discussion of improvement concepts and constraints is organized by goal. Each goal is accompanied by a brief review of related public comments. Improvement concepts and constraints are then summarized and discussed according to one of three implementation time frames: short-range, mid-range and long-range.

IMPROVE TRAVEL TIME

Commuters attending the public meetings held in communities along the Fitchburg Line from March through May 2003 frequently remarked that trip times from Fitchburg to North Station are too long; in fact, a comment was made that the trip time for commuter rail should at least be comparable to travel by personal auto, i.e. the trip time from Fitchburg to North Station should be in the range of 50 - 60 minutes. There are many factors that affect the speed on the line, and, in general, these factors relate to the number of stops, operational issues, signal settings and track conditions. The Fitchburg Line is currently the longest of all MBTA commuter rail lines in operation, at 49.5 miles in length. It currently has the greatest number of stations, 17 scheduled station stops along the line, and the highest average AM peak travel time, at just under 1.5 hours.

Table 3.1 below summarizes the improvement concepts and constraints associated with improving travel time between Fitchburg and North Station.

TABLE 3.1: Improve Travel Time

Implementation Time Frame	Improvement concepts	Constraints
Short-range	Consolidate stations	Possible passenger impacts
	Eliminate/reduce flag stops	Possible passenger impacts
	Increase travel speeds	Longer crossing gate closures; longer vehicle queues; track conditions
	Eliminate delays at Porter Square	Red Line transfers become less convenient
	Reduce time for crew changeover at Fitchburg	Contract/labor agreements
Medium-range	Expedite boarding/alighting	Train personnel and/or electrically actuated doors
	Reset grade crossing setbacks	Cost; longer vehicle queues
	Signal system improvements	Cost
Long-range	Double track	Cost

Short-Range — Consolidate Stations

The number of stops is an important factor with regard to speed along the line. As mentioned above, there are 17 stations not counting North Station on the Fitchburg line. There are various options that could be taken to reduce the number of stops. For express service, there could be a substantial reduction in the number of station stops. Currently, the #408 express train makes 8 station stops before reaching North Station and the #410 express train makes eleven station stops before reaching North Station, with a total trip time of 1:18 and 1:23, respectively. By comparison, other local inbound morning trains such as the #404, #406, and #412 make all seventeen stops with a trip time of 1:27, 1:32, 1:32, respectively. Clearly, a further reduction in the number of stations can significantly affect running times.

In an effort to quantify existing patronage at the stations along the Fitchburg Commuter Rail Line, station counts were conducted at select stations that could be consolidated to provide enhanced express service. Based on the station counts, there is a good opportunity to modify the existing schedule to increase the availability of express trains.

Under the proposed revised schedule, the #404 inbound train, which currently departs Fitchburg at 5:45 AM and arrives at North Station at 7:12 AM, would skip service at Hastings, Kendall Green, Brandeis/Roberts, Waverly and Belmont Stations resulting in a scheduled arrival at North Station of 7:05 AM resulting in a savings of seven minutes. In addition, the #412 inbound train, which currently departs Fitchburg at 7:20 AM and arrives at North Station at 8:52 AM, would skip service at West Concord, Concord, Lincoln, Silver Hill, Hastings, Kendal Green, Brandeis/Roberts, Waltham, Waverley, and Belmont. Finally, the #431 outbound train, which currently departs North Station at 5:20 PM and arrives at Fitchburg at 6:47 PM, would skip service at Lincoln, Concord, and West Concord resulting in a scheduled arrival at Fitchburg of 6:39 PM resulting in a savings of eight minutes.

The opportunity presented by the proposed modifications must be balanced against the potential inconvenience to passengers who would receive less service. There are approximately 83 inbound commuters who would be affected by the proposed change in #404 service. The impacts associated with the proposed modifications to the #412 train would have a negative impact for approximately 267 inbound commuters and the modifications to the #431 outbound would affect approximately 232 commuters.

It appears there is an opportunity to review the use and condition of all stations and develop a strategic plan. The strategic plan will carefully review all stations and recommend one of four options: major capital investment; basic improvements; leave as is; and phase out. This review would be based upon such factors as ridership generators, access to the station, existence of parking or potential for expansion of parking, station spacing, potential as an intermodal transportation facility, and other considerations. For example, in the town of Weston, there are three stations within 1.5 miles of each other. The Kendal Green station has 57 parking spaces, Hastings has 6 spaces, and Silver Hill has none. None of the Weston stations have bicycle spaces. One option might be to consolidate the Weston stations at Kendal Green as it is a larger facility with greater parking capacity. This change could likely be implemented with a minimal drop in ridership. However, abutting wetlands and poor highway access may work to limit expansion at this location. In the Town of Belmont, there are two stations, 1.0 mile apart. Neither station has parking. These stations are candidates for consolidation or elimination. The product of this effort would be a plan guiding the MBTA to focus scarce capital investment resources on the most important stations.

A preliminary inventory of the current station amenities provided at all stations on the Fitchburg line is attached in Appendix B and could be further expanded upon with the development of a strategic plan.

Short-Range — Eliminate or Reduce Flag Stops

Another opportunity to improve travel time would be the elimination of flag stops.[1] The only flag stop occurring at peak times is at Hastings on the #429, #471 and #433 PM peak trains.

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[1] As described by the MBTA, flag stops are "Stops to discharge passengers on notice to the conductor and to pick up passengers on platform visible to Engineer."

Flag stops add time to the schedule just as a regular stop. If no passengers are waiting at the flag stop, the train does not stop, but must slow before the next stop so that the schedule is maintained. At stops designated as flag stops, the stop could be made a regular stop or eliminated.

Short-Range — Increase Travel Speeds

Signal settings and track conditions have a significant influence on speed (and travel time) along the line. There is an opportunity to increase speeds, but this may be constrained by the current track conditions and effect at rail-highway crossings. The maximum speed for a majority of the line is 60 mph. If this were the case for the entire line, the train speed would match or exceed the speed of a personal auto. However, there are some areas where 60 mph is not achievable, since speeds are constrained by the 40 grade crossings along the line. If the crossing approach is not set back far enough, the train must slow down. A train moving at 60 mph approaching a grade crossing will start to close the crossing gates at a greater distance (i.e., sooner and keep the gates closed longer) than a train moving at 30 mph. The distance at which the gates must close for a given speed is set by FRA regulations. However, it is an operational policy to set the speed. If the train speed is lower approaching the grade crossing, the gates will start to drop later and stay down a shorter amount of time. There is a trade off between the needs of the commuter rail service for speed and the motorists who are delayed due to the crossing gates in the closed position. Since there are 40 grade crossings, this is a major factor in the overall speed along the line.

Short-Range — Eliminate Delays at Porter Square

It was reported that at the Porter Square Station the Fitchburg train is frequently delayed. If this is the case, it is most likely due to dispatchers holding commuter rail departures for the Red Line arrivals. It would seem that this should occur only when there is an unusual problem on the Red Line and not occur on a regular basis. The headways for the Red Line during peak time are frequent, so that passengers who leave sufficient time should be able to meet their connection with the Fitchburg commuter train.

Short-Range — Reduce Length of Crew Changeover at Fitchburg

A comment was expressed at the public meeting in the Fitchburg area that the time for the crew change-over just before the Fitchburg station is excessive and might as well be considered an additional stop. The timing of the crew change should be coordinated in such a way as to minimize the time and inconvenience to the passengers.

Medium-Range — Coach Door Opening

A suggestion was made to open all doors on each coach at busy commuter rail stops to expedite passenger boardings and alightings. Opening all doors offers an opportunity to improve boarding times; however, one constraint is that additional staff might be needed to open all doors, which could be cost prohibitive. One opportunity might be to specify electrically actuated doors in future train procurements, eliminating this manual function altogether. However, a significant constraint is that there is not a standard platform configuration. That is, some stations have at-grade platforms, others a mini-high platform, and some have full high platforms. Currently, conductors are able to ensure that the appropriate doors are opened at each station. This is a safety issue, particularly for passengers with disabilities. Platform variations are not expected to be unified within the foreseeable future, and therefore electrically actuated doors are not feasible.

Medium-Range — Reset Grade Crossings

As previously mentioned, train speeds are constrained by the existing grade crossings along the line. Since some of the crossing approaches are not set back far enough, the train must slow down before approaching the crossing. A significant constraint associated with resetting the grade crossings to accommodate higher speeds is the impact to waiting motorists. In order to accommodate higher speeds, the crossing gates need to close earlier than would be required for slower moving trains, thus requiring the motorists to wait longer. A balance between the needs of commuters and motorists is required.

Medium- Range — Signal System

Improvements to the existing signal system along the Fitchburg Commuter Rail Line would allow for improved travel times. As mentioned in the public hearings, the existing signal system has been reported to fail, thus causing service delays.

Long-Range — Double-Track

In an effort to improve travel time between Fitchburg and North Station, there is an opportunity to double-track the entire branch. The speed on single track sections is restricted (30 mph in Waltham and 40 mph from S. Acton to the Willows). Another benefit of double tracking with regard to speed is that express trains have the ability to pass local trains and any commuter rail train can pass slower freight trains. Double tracking opens up greater options for scheduling simultaneous inbound and outbound trips, as well as expanding reverse commute options. Double tracking is also a major advantage for maintenance. Now, maintenance on single-track sections must be done during narrow windows of time when no service is scheduled or during costly off shifts.

The sections of track that are single track are: (1) in Waltham, before and slightly past the Waltham train station, for about 0.5 miles, and (2) from S. Acton to Littleton to the Willows in Ayer, a section of about 8.5 miles. The single-track section in Waltham could be addressed first as all commuter rail trains on the line go through this bottleneck, and it is a relatively short section, hence a less expensive fix. The section from the S. Acton to the Willows is also important because it is a much longer section, creating a longer bottleneck (up to 20 minutes) and is heavily utilized by freight carriers as well as Fitchburg commuters. It is assumed that the existing right-of-way along the Fitchburg branch will adequately support the installation of a double track since it has in the past.

Cost and the numerous at-grade crossings, however, are potential constraints to the development of double-tracks. The Fitchburg Commuter Rail Line has three at-grade crossings in the Town of Acton between the South Acton Commuter Rail Station and the Boxborough Town Line. A crossing occurs at Martin Street, and twice on Central Street (once west of Route 111 and once east of Route 111).

IMPROVE PASSENGER COMFORT

Commuters participating in the public meetings held between March and May 2003 voiced an interest in increased passenger amenities including, but not limited to, increased sheltered seating, better bike storage facilities, improved temperature controls on the trains, reliable station maintenance, and increased train capacity. The improvement concepts and constraints for this goal are summarized in Table 3.2.

TABLE 3.2 Improve Passenger Comfort

Implementation Time Frame	Improvement concepts	Constraints
Short-range	Add sheltered seating	Cost
	Improve station lighting	Cost
	Increase station maintenance	Cost
	Provide bicycle storage	Cost; availability of space
Medium-range	Station improvement program creating indoor waiting facilities/amenities	Cost; space; local plans/ordinances
Long-range	Increase number of seats	Equipment availability

Short-Range — Sheltered Seating, Well-lit Platforms and Bicycle Racks

There is an opportunity to provide certain basic passenger amenities at stations along the Fitchburg Line. Sheltered seating, well-lit platforms, and bicycle storage facilities are among the most requested amenities. The stations currently providing the basic passenger amenities have no program in place to monitor the maintenance and cleaning of these amenities. There is an opportunity to expand the "Cleaning Between the Lines" program (which is designed to monitor the performance of their contract cleaners at subway stations) to include the monitoring of the scheduled maintenance at commuter rail stations.

Installing bicycle racks provides commuters with an alternate method of accessing stations, especially during non-winter months. This may be a useful low-capital cost opportunity to enhance access at stations that have limited parking.

Medium-Range — Indoor Waiting Facilities

There is an opportunity to construct indoor waiting facilities at stations. These facilities would offer restrooms, protection from the weather, telephones, schedules, automated ticket machines and other amenities. Although indoor facilities have been requested by patrons of the Fitchburg Commuter Rail Line, funding, availability of space, and local community plans and ordinances may serve to constrain construction of these facilities. However, there may be an opportunity to partner with the private sector in order to provide the requested amenities. The MBTA could construct the shell of the desired facility and then issue an RFP or IFB for a small convenience store operator or coffee shop to occupy the shell. Lease revenue would then support the installation and maintenance of the amenities. One constraint is that an RTA, vendor, or host community would have to agree to maintain the facility. The MBTA, working under fiscal constraints, is unlikely to accept a new maintenance responsibility.

Long-Range — Increased Seating

The opportunity to provide additional peak hour capacity with increased seating can be accommodated with the addition of extra cars or double-decker cars on existing trains. In addition, additional peak hour capacity without additional ridership demand would provide existing patrons with increased personal space onboard the train – allowing patrons to sit further apart. The use of extra cars on trains or even the use of double-decker cars, however, is expensive and needs further analysis of future passenger demands. Currently, there are no double-decker trains operating out of North Station. The MBTA is, however, continuously upgrading and improving their rolling stock to acquire additional capacity system wide, and MBTA policy states that all future capacity acquisitions will be double-decker cars. In addition, it should be noted that the MBTA guidelines for commuter rail lines permit load levels equal to 110% of seated capacity, and thus providing additional capacity without comparable levels of ridership is not likely to occur.

IMPROVE SERVICE RELIABILITY

Commuters participating in the public meetings feel the Fitchburg Commuter Rail Line is frequently delayed. However, according to data reported by the MBTA, the Fitchburg Commuter Rail Line has a 95%[1] on-time record. This statistic was determined based on trains departing/arriving within five minutes of their scheduled time. On July 1, 2003, a new operator, the Massachusetts Bay Commuter Rail (MBCR), assumed the operation of the MBTA's commuter rail service. As a result, on-time performance of MBCR may differ from Amtrak, the company that operated the service at the time of the public meetings held from March through May 2003.

The improvement concepts and constraints related to improving service reliability are summarized below in Table 3.3.

TABLE 3.3: Improve Service Reliability

Implementation Time Frame	Improvement concepts	Constraints
Short-range	Monitor system reliability	None
	Install continuously welded track	Cost Single track sections of line
Medium-range	Maintain and improve signals	Cost
	Other infrastructure improvements	Cost
Long-range	Double track	Cost

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[1] MBTA Worcester Service Expansion Study, Prepared by KKO & Associates, April 2002.

Short-Range — System Reliability

Specific comments received from the public hearings (that were made while Amtrak, the former operator, was involved) included: (1) the 5:45 AM train was late arriving North Station, (2) the 6:20 PM train was late arriving Fitchburg, (3) delays were experienced at Porter Square (as discussed earlier), and (4) delays were experienced in Fitchburg at the crew change over point (also discussed earlier).

In order to determine whether there is a systemic reliability problem, all delays and other operational and equipment problems should be well-documented over a six-month period, including winter months. The results should be reviewed by an ad hoc panel of MBTA staff, MBCR personnel, the Guilford Transportation Company and McM. The results of the review may lead to suggestions that will improve service reliability.

Short-Range — Track Conditions

One early action opportunity that would have wide ranging benefits for the line would be to install welded track throughout the line. Welded track offers the potential for higher train speeds, smoother rides, and easier maintenance. As of January, 2005, some welded track has already been installed or is in progress on the line, but approximately 50% is left to be done. The constraints to installing all welded track are the cost and scheduling the work so that service on the line is not disrupted. This is of particular concern in the sections of the line that are single track.

Medium-Range — Signal System Improvements

Rehabilitation of the existing signal system was also mentioned at the public hearings as a possible means of improving reliability. The signal system, primarily between Waltham and Lincoln, is reported to frequently fail after severe thunderstorms. In addition, many of the current switches are manually operated and thus upgrading to continuously welded track allows the opportunity to improve the speed of signal performance.

Medium-Range — Infrastructure Improvements

Meetings with Guilford Rail Systems, the freight carrier that shares the track with the MBTA Fitchburg commuter line, have suggested a need for additional rail sidings, automatic interlocking in Ayer, and a crossover in Shirley. These improvements would facilitate enhanced passenger and freight movements on the line.

Long-Range — Double-Track

As previously mentioned, in an effort to improve travel time and service reliability between Fitchburg and North Station, there is an opportunity to double-track the entire branch. Double tracking opens up greater options for scheduling simultaneous inbound and outbound trips, as well as expanding reverse commute options. Double tracking is also a major advantage for maintenance. Cost and the numerous at-grade crossings, however, are constraints to the development of double-tracks.

MEET RIDERSHIP DEMANDS

The Fitchburg Commuter Rail Line serves approximately 19 percent of the total number of commuter rail passenger volume on the north side of Boston, operating 25 trains per day between Fitchburg and North Station. The first inbound train arrives North Station at 7:12 AM, and the first outbound train arrives Fitchburg at 10:15 AM. During the afternoon peak period (4:00 PM – 7:00 PM), there are only four trains leaving North Station to Fitchburg. A gap of 1:20 exists between the last peak train (6:15 PM) and the first off-peak train to depart North Station to Fitchburg.

During the off peak times, there are several large gaps in the service to Fitchburg. Inbound, there are gaps in service between 7:20 AM and 10:27 AM and from 3:05 PM and 6:12 PM. Outbound, there is a significant gap from North Station to Fitchburg from 1:20 PM and 3:00 PM.

According to data provided in the October, 2004 CTPS report, an additional 270 weekday morning boardings could develop by 2025 if service improvements are implemented. The improvement concepts and constraints associated with meeting ridership demands are shown below in Table 3.4.

TABLE 3.4: Meet Ridership Demands

Implementation Time Frame	Improvement concepts	Constraints
Short-range	Schedule improvements	Cost; equipment; yard space; double-tracking; freight movement; equipment/crew availability
Medium-range	Reverse commute	Scheduling; existing demand; return on investment
	Phase in Gardner van/bus shuttle to Fitchburg	Funding; implementation
Long-range	Schedule additional trains	Scheduling; equipment availability
	Line extension to Wachusett and Gardner	Distance; travel time; track ownership; high capital cost to rider ratio; funding availability; grade elevation change
	Reverse commute	Forecast demand; return on investment

Short-Range — Schedule Improvements

In addition to the proposed modifications to the inbound #404, inbound #410 and outbound #431 mentioned previously, there are opportunities to operate new trains to supplement both the morning and evening commuter service. These include the inbound #402, which could depart Fitchburg at 5:05 AM and arrive at North Station at 6:30 AM and the inbound #452, which could depart South Acton at 7:40 AM and arrive at North Station at 8:34 AM. Each proposed train is expected to add approximately 650 seats. The proposed new service provided by the #402 inbound train is in response to a public request for earlier service from Fitchburg to permit arrivals at North Station prior to 7:00 AM.

Opportunities to expand outbound service include a proposed #451 train, which would depart North Station at 6:40 AM and arrive at the South Acton Station at 7:30 AM. For evening outbound service, there is an opportunity to implement a #427 outbound train, which would depart North Station at 3:45 PM and arrive at Fitchburg at 5:11 PM. This would fill a large gap in outbound evening service.

A principal constraint is cost. New locomotives currently cost about $2,000,000 each and coaches about $1,800,000 each and to ensure scheduling efficiency, all new trains must be compatible with the existing ones. A train operating out of North Station would need at least five coaches, at a cost of about $11,000,000 including the locomotive. Another major constraint associated with operating additional trains is the availability of yard space to store the trains and the ability to schedule additional trains within the existing rail timetable. The current location of the existing Fitchburg layover facility also has an adverse effect on the schedule and timetable. The current facility is located before the last station stop, forcing crew changeovers to occur between stations. Although addressing the problems associated with the current location of the layover facility is beyond the short-range scope, the long-term effect of the short-term scheduling changes requires further investigation.

Medium-Range — Reverse Commute

There may be an opportunity for reverse commute service, particularly to the Waltham Station. The Central Transportation Planning Staff (CTPS) studied the issue several years ago; in their study, they identified a number of constraints. However, new census data has since become available. The Journey-to-Work data from the 2000 U.S. Census is shown in Table 3.5 below. The total population reported to live within the City of Boston and work within the communities along the Fitchburg Commuter Rail Line is 5,473.

According to the census tabulations, approximately 91 people live within the City of Boston and work in either Fitchburg or Gardner and an estimated 112 people live within the City of Boston and work in either Leominster or Shirley. There are significantly more people who live within the City of Boston and work in Waltham (3,740), suggesting that this may present an emerging reverse commute service opportunity.

Table 3.5: Daily Worker Flow from Boston to Fitchburg Commuter Rail Line Communities

Workplace	Residence: Boston
Acton	236
Athol	36
Ayer	35
Belmont	484
Concord	501
Fitchburg	62
Gardner	29
Lincoln	109
Littleton	129
Leominster	105
Shirley	7
Waltham	3,740
Total	5,473

Source: 2000 U.S. Census Journey-to-Work

The CTPS report noted a number of serious constraints. Currently, the first train to arrive at Fitchburg on a weekday is at 10:15 in the morning, thus practically eliminating the possibility of reverse commuting to the Fitchburg area. The report found that the MBTA commuter rail network is not well suited for providing reverse commuting services at this time for many reasons.

Station locations are not conveniently located to accommodate reverse commute patrons. Within Boston the majority of residential areas are not within walking distance from commuter rail stations, requiring the timely use of one or more connecting services for access. Typically, within the suburban destinations the location of major employers is beyond walking distance of stations, requiring employers to provide a connecting service.

Current MBTA Commuter Rail schedules are determined largely by the requirement for cycling equipment efficiently between trips. The outbound AM peak trains are scheduled around the equipment needs of the inbound AM peak trains and the inbound PM peak trains are scheduled around the equipment needs of the outbound PM peak trains. In addition, all trains are stored at the Fitchburg layover facility, so an additional train set to be stored within Boston would be required.

Aside from the constraints of scheduling the equipment appropriately, scheduling of reverse commute trains is constrained by the segments of single track located between the South Acton Station and Ayer. Single track restricts the locations where inbound and outbound trains can meet and where Commuter trains can pass freight trains. Double tracking is needed to provide an opportunity to expedite the commuter rail service, which is currently running on freight lines, provide opportunities for express trains, and allow for increased flexibility in train scheduling.

An updated analysis of the potential for reverse commute on the Fitchburg Rail Line completed by CTPS in October, 2004 reports that in 2025, 20 new boardings would be expected in the AM peak period with the creation of a reverse commute schedule. Although there is the potential for job growth within the Fort Devens area, there are not a significant number of jobs within walking distance to the commuter rail stations.

A pilot program for reverse commute opportunities is currently proposed at the Anderson Regional Transportation Center in Woburn, Massachusetts. Anderson Station has various sources of employment both adjacent to, and in the immediate vicinity of the station, and has the greatest potential to benefit from reverse commuting schedules. Pending successful implementation and operation of the reverse commute schedule to the Anderson Station, the MBTA will begin investigating other potential opportunities within their service area.

Medium-Range — Gardner Van/Bus Shuttle

There is an opportunity to extend the current service beyond Fitchburg to the greater Gardner region. This creates an opportunity to expand service to low-income populations and older urban centers that currently do not have convenient access to commuter rail service. It can also be a tool for economic development. The first step would be to institute interim feeder bus service. This could be accomplished by locating a new “Park-and-Ride” facility between Fitchburg and Gardner and running shuttle buses to the Fitchburg Station. Perhaps MART can receive assistance to underwrite the cost of a pilot program. This would begin to build ridership in the area beyond Fitchburg.

However, a line extension all the way to Gardner would significantly increase the already lengthy running times, which is inconsistent with the goal to improve travel times. A significant benefit of a line extension is the additional parking available to supplement the existing parking at Fitchburg Station, which currently serves all patrons west of Fitchburg. Gardner also has better Route 2 access than Fitchburg. Although track currently exists between Fitchburg and Gardner, it would need improvements since service between the two has been discontinued since 1986.

Long-Range — Additional Trains

There is an opportunity to provide additional peak hour capacity on the trains with additional service; operating additional trains during the peak hours can do this. The inclusion of additional trains was previously discussed and the opportunity exists to supplement both the morning and evening commuter service with new trains.

Long-Range — Line Extension

Two alternatives for extending the Fitchburg Commuter Rail Line have been proposed, an extension to Wachusett Station, and an extension Gardner. Extending the line to Gardner entails an approximately 16 mile track extension, including a nearly 600 foot rise in altitude.

Extending the line to the interim Wachusett Station entails only an approximately 3 mile track extension and 40 foot rise in altitude.

A track extension to Gardner should be accompanied by extensive upgrading of tracks and signals. The service would attract an estimated daily ridership of 50.[1] This could prove to be significant as it relates to this project's ranking as a long-term effort. Since only 50 riders are projected to use this service if it is implemented by 2025, and with a projected capital cost of approximately $50.5 million, the capital cost per rider is $1,010,625. Significant resources will have to be mustered on both a state and federal level in order to underwrite such a substantial capital cost. Prior to expending funds for rail service, phasing in a regional bus shuttle from Gardner to Fitchburg Station will be a useful tool in gauging actual regional demand for service from Gardner.

Although a track extension to the proposed Wachusett Station should be accompanied by extensive upgrading of tracks and signals as well, the length of track is significantly less than an extension to Gardner. In addition, the proposed Wachusett Station, approximately three miles west of the Fitchburg Station, would be located adjacent to Routes 2 and 31, providing better access to communities west of Fitchburg.

Other constraints associated with a line extension west of the existing Fitchburg Station include the ownership and availability of the line west of Fitchburg by GRS. As discussed in Task 2, the MBTA owns the infrastructure from Boston to Fitchburg and STR has rights to operate. West of Fitchburg, GRS owns the infrastructure so that the MBTA would be required to negotiate an easement for operation of commuter rail service. Fitchburg to Gardner is 17 track miles and from Gardner to Athol is another 17 track miles. Service to Gardner would add approximately 34 minutes to the travel time (assumed speed 30 mph) from Fitchburg to Boston, already about 1.5 hours in length. Service from Athol to Gardner would add another 34 minutes. From Fitchburg to Gardner, about ten miles is single track, the rest is double track and from Gardner to Athol about eight mile is single track. At one time the line was fully double tracked and the rail right of way exists, however at the present time a major portion is single track.

Another factor to be considered is the grade change west of Fitchburg. The elevation of Fitchburg is 462 feet, and at East Gardner the elevation is 1,116 feet. Locomotives with sufficient horsepower would be required to operate over this portion of the line. The same regular freight through trains that operated from Ayer to Fitchburg also operate through the greater Gardner region. Four regular eastbound and four westbound trains operate daily, as well as regular local trains. Coordination of freight and passenger service would be required over an additional 17 or 34 miles to Gardner or Athol respectively.

Passenger service from Boston to Gardner was provided in the past by the B&M. Passenger service to Gardner and Athol is possible, however a determination must be made whether the benefits of additional service can be justified in light of additional time and cost.

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[1] Program for Mass Transportation, May 2003.

Long-Range — Reverse Commute

Employment forecasts for some of the communities serviced by the Fitchburg Commuter Rail Line are summarized in Table 3.6, and may be useful is estimating future demand for reverse commute services. As shown in the table, future employment numbers are expected to decrease within Ayer and Belmont and are expected to moderately increase within the other communities reported.

Table 3.6: Current and Forecast Employment
Fitchburg Commuter Rail Communities

Town/City	2001	2015	2025
Acton	10,393	11,688	12,564
Ayer	6,328	6,089	5,915
Belmont	6,483	5,837	5,356
Concord	12,828	13,335	13,708
Lincoln	2,040	2,230	2,356
Littleton	5,706	7,088	8,011
Shirley	2,174	2,972	3,530
Waltham	60,793	61,231	61,639

IMPROVE OVERALL QUALITY OF SERVICE

Over two-thirds (69%) of all commuter rail patrons interviewed for the 1999 Commuter Rail Passenger Survey by the Montachusett Regional Planning Commission described the Fitchburg Commuter Rail Line as either excellent (15%) or good (54%).

The improvement concepts and constraints associated with improving the overall quality of service on the Fitchburg Commuter Rail Line are shown in Table 3.7.

TABLE 3.7: Improve Overall Quality of Service

Implementation Time Frame	Improvement concepts	Constraints
Short-range	Pass/Ticket Sales	Staff
	Monitor “Write to the top” responses and review pricing policies	Staff
Medium-range	Develop station improvement plans	
	Real-time information	Cost
Long-range	Develop regional parking facility at Rt. 495/ Rt. 2	Lack of agreement about location/impact of facility; environmental constraints; local politics

Early-Action — Pass/Ticket Sales

MBTA Commuter Rail passes can be purchased at MBTA station stops within the City of Boston as well as at selected locations in communities served by commuter rail. Patrons of the Fitchburg Commuter Rail Line may purchase monthly passes and 12-ride tickets not only at North Station, but also in Fitchburg, Concord, Shirley, Waltham, and West Concord. Single ride tickets are available on board the train. There is an opportunity to expand ticket/pass sales at all commuter rail stations using pay-on-foot systems; this would serve to improve the overall quality of service for Commuter Rail patrons.

Short-Range — "Write to the top" and Pricing Policies

Residents attending the public hearings voiced further concerns regarding the monitoring of the "Write to the Top" program and the current pricing/zoning policies for the Fitchburg Line. There is an opportunity to use the program in two ways. First, it can be used to provide individual riders with a quick response on short-term or daily concerns. It can also be used as an "early warning system", alerting the MBTA to emerging problems. MBTA zoning and pricing policies have recently been revised.

Medium-Range — Station Improvements

Currently only five of the 17 stations located along the Fitchburg Commuter Rail Line are accessible to persons with disabilities. These stations are Fitchburg, North Leominster, West Concord, Brandeis/Roberts, and Porter Square. There is an opportunity to upgrade additional stations along the line. As previously mentioned, preliminary station profile amenity sheets are attached in Appendix B.

Medium-Range — Real-time Information

LED signs are currently available at all MBTA Commuter Rail Stations, although real-time information is not. The existing sign program could be updated to include real-time commuter rail information for patrons awaiting trains. Possible constraints include the cost of installing telecommunications lines.

Long-Range — Regional Parking

There is an opportunity to create additional parking capacity along the line. Although several locations have been considered for a regional parking facility, further studies are needed to determine the feasibility of major station upgrades and/or the creation of regional parking facilities. One potential location for a regional facility is near the Route 2/I-495 interchange. Station upgrades and parking will be essential to support increased ridership.

SUMMARY OF IMPROVEMENT CONCEPTS AND CONSTRAINTS

This chapter briefly summarized the wide range of improvements that have been discussed for the Fitchburg Commuter Rail Line in relation to the overall goals of the study. The improvement concepts and constraints associated with the improvements encompass a range of items to be accomplished as a short-, medium-, or long-range action. The following table summarizes the potential improvement concepts for improvement.

SHORT-RANGE	Consolidate stations
	Eliminate/reduce flag stops
	Increase travel speeds
	Eliminate delays at Porter Square
	Reduce length of crew changeover at Fitchburg
	Add sheltered seating
	Improve station lighting
	Provide bicycle storage
	Monitor system reliability
	Improve track conditions
	Schedule improvements
	Pass/Ticket sales
	"Write to the top" and pricing policies
MEDIUM-RANGE	Expedite boarding/alighting
	Reset grade crossing setbacks
	Signal system improvements
	Indoor waiting facilities
	Other infrastructure improvements
	Initiate reverse commute
	Gardner van/bus shuttle
	Station improvements
	Real-time information
LONG-RANGE	Double track
	Additional service
	Increased seating
	Line extension: Wachusett/Gardner
	Expand reverse commute
	Regional parking

TASK 4: FUTURE CONDITIONS

A wide range of potential improvements has been discussed for the Fitchburg Commuter Rail Line. The evaluation of existing conditions, the efforts made to identify improvement goals and objectives, and the understanding of improvement concepts and constraints provide the framework for alternative service improvement packages for the Fitchburg Commuter Rail Line. The improvement concepts and constraints associated with these improvements were discussed in detail within Task 3 and were categorized according to whether they are short-range, medium-range, or long-range action items. This chapter takes the process to the next step, which is developing three alternative improvement packages based on the implementation period of short-range, medium-range, or long-range, for detailed analysis and evaluation.

SHORT-RANGE IMPROVEMENTS

The following table summarizes the potential improvement concepts previously categorized as Short-Range improvements, i.e. they can be implemented immediately or within five years.

TABLE 4.1: Short-Range Improvements

Improvement	Goal
Consolidate stations	Improve Travel Time
Eliminate/reduce flag stops	Improve Travel Time
Increase travel speeds	Improve Travel Time
Eliminate delays at Porter Square	Improve Travel Time
Reduce length of crew changeover at Fitchburg	Improve Travel Time
Add sheltered seating	Improve Passenger Comfort
Improve station lighting	Improve Passenger Comfort
Provide bicycle storage	Improve Passenger Comfort
Monitor system reliability	Improve Service Reliability
Improve track conditions	Improve Service Reliability
Schedule improvements	Meet Ridership Demands
Pass/Ticket Sales	Improve Overall Quality of Service
"Write to the top" and pricing policies	Improve Overall Quality of Service

As shown in Table 4.1, the individual components of the short-range alternative relate to all five broad goals for the Fitchburg Commuter Rail Line: improve travel time, improve passenger comfort, improve service reliability, meet ridership demands, and improve overall quality of service.

Some components of the short-range improvement package are on-going management functions and do not require further review within the context of this report. Specifically, on-time performance is a critical performance measurement being monitored by MBCR and the MBTA. According to documentation provided by the Massachusetts Bay Commuter Railroad Company (MBCR) dated March 26, 2004, the Fitchburg Commuter Rail Line operated on-time 91.67% of the time for March 2004 month and 94.23% for the previous month. Since the monitoring of on-time performance and system reliability is an on-going concern for MBCR, it will not be considered further within this report.

The suggestions for improved monitoring of the "Write to the top" program and review of the current pricing policies for the commuter rail service have also already been implemented by the MBTA, and therefore, do not require further review within this study. The MBTA has a policy in place to ensure proper monitoring/responses of the "Write to the top" program and pricing changes were implemented in January 2004. Pricing changes included a revision of both the current zone structure and rate structure.

Some improvements suggested as improvement concepts within the short-range improvement package, however, are not feasible for implementation along the Fitchburg Commuter Rail Line at this time, and will not be further considered within this study. Specifically, it is not feasible to eliminate delays at Porter Square or to reduce the length of crew changeovers at Fitchburg.

On occasions where the Red Line rapid transit service is operating with significant delays, the Commuter Rail Train servicing Fitchburg is held at the Porter Square Station to accommodate patrons delayed by subway service. The practice of holding trains at Porter Square only occurs in extreme cases and is not considered an issue which requires further consideration at this time.

According to current MBTA policy, crew changeovers are scheduled during off-peak times whenever possible. In the case of the Fitchburg Line, a crew changeover during peak service is unavoidable at times. Although crew changeovers may seem like a disruption in service to the passengers, they are planned and operated as efficiently as possible given the current schedule, equipment, and staff availability. Therefore, reducing the length of crew changeovers is not feasible.

The following list briefly summarizes the remaining improvement concepts considered for implementation along the Fitchburg Commuter Rail Line as part of the short-range improvement package:

- *Consolidate Stations* – There are 17 stations (not counting North Station) on the Fitchburg line, and the number of stops is an important factor with regard to travel time. A reduction in the number of station stops would decrease the total travel time. Possible stations for consolidation include Kendal Green, Hastings, and Silver Hill Station.

- *Eliminate/Reduce Flag stops* - Another opportunity to improve travel time would be the elimination of flag stops.[1] The only flag stops occurring at peak times are at Hastings on the #467, #429, #471 and #433 PM peak trains. Flag stops add time to the schedule just as a regular stop. If no passengers are waiting at the flag stop, the train does not stop, but must slow before the next stop so that the schedule is maintained. At stops designated as flag stops, the stop could be made a regular stop or eliminated.

- *Sheltered Seating, Improved Station Lighting and Bicycle Storage* - There is an opportunity to provide certain basic passenger amenities at stations along the Fitchburg Line. Sheltered seating, well-lit platforms, and bicycle storage facilities are among the most requested amenities. Station amenities were recently updated at the Ayer, North Leominster, and South Acton Stations.

- *Improve Track Conditions* – A program is currently underway to upgrade the Fitchburg Line with continuously welded track. During calendar year 2004, the outbound track should consist of all continuously welded track. However, the inbound track is still in need of upgrading. Continuously welded track will improve reliability and on-time performance, improve travel time, and most importantly reduce the possibility of derailments due to rail failures.

- *Schedule Improvements* - In addition to the schedule modifications implemented February 17, 2004 as a result of the preliminary findings and recommendations of this study, there are additional opportunities to make minor scheduling changes without additional rolling stock or train crews that would respond to some riders' concerns. These include extending the 3:00 PM outbound train from South Acton to Fitchburg. This train could then be run inbound from Fitchburg at 5:00 PM, arriving at North Station at 6:25 PM in time for evening events at the Fleet Center or other Boston destinations. The 4:50 PM outbound train could end at South Acton and return to North Station at 6:00 PM. Since the new express 4:40 PM train carries most of the passengers to South Acton and makes all station stops to Fitchburg, the portion of the 4:50 PM from South Acton to Fitchburg is redundant. The 4:40 PM train could end in Fitchburg, which presently turns into the 6:12 PM inbound, and could be eliminated and replaced by the proposed 5:00 PM inbound.

- *Pass/Ticket Sales* - Patrons of the Fitchburg Commuter Rail Line may purchase monthly passes and 12-ride tickets at North Station, Fitchburg, Concord, Shirley, Waltham, and West Concord. Single ride tickets are available on board the train. There is an opportunity to expand ticket/pass sales at all commuter rail stations using pay-on-foot systems; this would serve to improve the overall quality of service for commuter rail patrons.

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[1] As described by the MBTA, flag stops are "Stops to discharge passengers on notice to the conductor and to pick up passengers on platform visible to Engineer."

MEDIUM-RANGE IMPROVEMENTS

The following table summarizes the potential improvement concepts for improvement as categorized as medium-range improvements, i.e. they have the potential for implementation over the next five to ten (5-10) years.

TABLE 4.2: Medium-Range Improvements

Improvement	Goal
Expedite boarding/alighting	Improve Travel Time
Reset grade crossing setbacks	Improve Travel Time
Signal system improvements	Improve Travel Time/Service Reliability
Indoor waiting facilities	Improve Passenger Comfort
Other infrastructure improvements	Improve Service Reliability
Initiate reverse commute	Meet Ridership Demands
Gardner van/bus shuttle	Meet Ridership Demands
Station improvements	Improve Overall Quality of Service
Real-time information	Improve Overall Quality of Service

As shown in Table 4.2, the individual components of the medium-range alternatives relate to all five broad goals for the Fitchburg Commuter Rail Line: improve travel time, improve passenger comfort, meet ridership demands, improve service reliability, and improve overall quality of service.

Some improvement concepts suggested within the medium-range improvement package, however, are not feasible for implementation along the Fitchburg Commuter Rail Line given the current conditions, and will not be further considered within this study. Specifically, it is not feasible to expedite boardings and alightings.

Although opening all doors could offer an opportunity to improve boarding and alighting times, additional staff would be needed to open all doors, which would be cost prohibitive. Electrically actuated doors could also be specified in future train procurements, eliminating the manual function altogether; however, a significant constraint is that there is not a standard platform configuration. That is, some stations have at-grade platforms, others a mini-high platform, and some have full high platforms. Currently, conductors are able to ensure that the appropriate doors are opened at each station. This is a safety issue, particularly for passengers with disabilities. Therefore, no further consideration of expediting boardings and alightings is analyzed within this study.

The following list briefly summarizes the remaining improvement concepts considered for implementation along the Fitchburg Commuter Rail Line as part of the medium-range improvement package:

- *Reset Grade Crossing Setbacks* – Train speeds are constrained by the existing grade crossing setbacks along the line. Many sections of the track are rated at 60 mph. However, to achieve rated speeds at grade crossings, crossing gates must be lowered when the train arrives at a greater distance from the crossing. Some of the crossing approaches are not set back far enough for the rated speed, so trains must operate at slower speeds through the crossing. MBTA policy for commuter rails is to have speeds of 70 mph. However, to obtain the goal of 70 mph all grade crossing setbacks would have to be relocated. Further analysis is needed to determine the cost benefit of increasing the speeds with setbacks.

- *Signal System Improvements* – The existing signal system is well beyond its useful life. Many of the grade crossing warning devices utilize mechanical parts that can operate improperly causing failure to activate situations. The major benefits of upgrading the signal system are safety and reliability, improved travel time and increased operational flexibility.

- *Indoor Waiting Facilities* - Only four Fitchburg Line stations have indoor waiting facilities: Porter Square, Concord (restaurant adjacent to platform), West Concord (restaurant adjacent to platform), and Fitchburg. The other thirteen stations have canopies or enclosures. Shirley has a station building with one open side. Station profiles are shown in Appendix B.

- *Other infrastructure improvements*. Meetings with Guilford Rail Systems, the freight carrier that shares the track with the MBTA Fitchburg commuter line, have suggested a need for additional rail sidings, automatic interlocking in Ayer and a crossover in Shirley. These improvements would facilitate enhanced passenger and freight movements on the line.

- *Initiate Reverse Commute* – Based on 2000 U.S. Census Journey to Work data, demand may exist for reverse commute service, particularly to the Waltham Station. With growth in the economy, greater demand may develop in the communities further west of Boston served by the Fitchburg Line.

- *Gardner Van/Bus Shuttle* – The demand for commuter rail service has been reported between Gardner and Boston. The first step would be to institute interim feeder bus service. This could be accomplished by locating a new "Park-and-Ride" facility in Gardner and running shuttle buses to the Fitchburg Station for commuter rail patrons. This service would need to be coordinated with MART.

- *Station Improvements* – Station improvement projects are currently underway in Fitchburg and have recently been completed in North Leominster. Fitchburg station has an attractive, new transit intermodal building and a parking garage with 400 car capacity is scheduled to open in 2005. The North Leominster station has recently been relocated, and a new parking lot with 150 car capacity opened. Ayer station is currently in the conceptual design stage for a substantial improvement program, with a proposed 320 car parking garage. Montachusett Regional Transit Authority (MART) has taken the lead on these projects.

- *Real-time Information* – LED signs are currently available at all MBTA Commuter Rail Stations, although real-time information is not. The real time passenger information system program should be implemented in conjunction with signal and communications system upgrades.

LONG-RANGE IMPROVEMENTS

The following table summarizes the potential improvement concepts for long-range improvements, i.e. they are expected to take 10 or more years to complete.

TABLE 4.3: Long-Range Improvements

Improvement	Goal
Double Track	Improve Travel Time/Service Reliability
Additional service – peak/off peak	Meet Ridership Demands
Increased seating	Improve Passenger Comfort
Line extension: Wachusett/Gardner	Meet Ridership Demands
Expand Reverse commute	Meet Ridership Demands
Regional parking	Improve Overall Quality of Service

As shown in Table 4.3, the individual components of the long-range alternative relate to all five broad goals for the Fitchburg Commuter Rail Line: improve travel time, improve passenger comfort, meet ridership demands, improve service reliability, and improve overall quality of service.

The following list briefly summarizes the improvement concepts considered for implementation along the Fitchburg Commuter Rail Line as part of the long-range improvement package:

- *Double Track* – In an effort to improve travel times, reliability, and on-time performance, double tracking between South Acton and the Willows and in Waltham is proposed. Double tracking these areas will eliminate delays caused by trains using the single track. Any delays or breakdowns can cause cascading delays to other MBTA trains. Double tracking opens up greater options for scheduling simultaneous inbound and outbound trips, as well as expanding reverse commute options. Double tracking is also a major advantage for maintenance.

- *Additional Service* – Additional peak and off peak service has been requested to provide this service, additional rolling stock and train crews will be required.

- *Increased Seating* – The opportunity to provide additional peak hour capacity with increased seating can be accommodated with the addition of extra cars, or double-decker cars, on existing trains. Currently, there are no double-decker trains operating out of North Station. The MBTA is, however, continuously upgrading and improving their rolling stock to acquire additional capacity system wide, and MBTA policy states that all future capacity acquisitions will be double-decker cars.

- *Line Extension* – After successful implementation of the interim feeder bus service, a 15.6 mile track extension could be implemented to Gardner, or a 4 mile track extension to a new Wachusett Station. The track extension should be accompanied by extensive upgrading of tracks and signals.

- *Expand Reverse Commute* – Additional reverse commute service could be implemented, if proven effective, once the constraint of single track segments and equipment scheduling have been alleviated.

- *Regional Parking* – There is a need for an additional 500[1] car parking facility serving the region west of I-495. Although several locations have been considered, further studies are needed to determine the optimal location for such a regional parking facility. One potential location for a regional facility is near the Route 2/I-495 interchange.

MATRIX EVALUATION

A comparative matrix evaluating each of the improvements suggested for the short-range, medium-range, and long-range improvement packages was created and a copy is attached in Appendix C. As shown within the matrix, improvements were ranked on a scale of -1, 0, and 1 for negative, negligible, and positive impacts, respectively, associated with the improvement.

The analysis is based on the suggested improvements performance in terms of utilization, mobility, cost-effectiveness, air quality, service quality, economic impacts, land use impacts, and environmental justice as outlined as analysis criteria in the “Program for Mass Transit”. The basis of analysis for the terms is briefly summarized below.

- Utilization – based on a projected increase in new and existing ridership, and/or a reduction in travel time.

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[1] The need for 500 spaces was identified in the Program for Mass Transportation dated May 2003, Revised January 2004.

- Mobility – based on expansion of transit service to underserved areas, expansion of transit during off-peak periods, or expansion of service to major employment centers.

- Cost-Effectiveness – based on a benefit to cost ratio that includes only improvements that will have a monetary benefit generating increased fares or revenues or decreased costs.

- Air Quality – based on a projection that the cumulative reduction in personal auto emissions is greater than the comparable rail locomotive emissions.

- Service Quality – based on enhancements to patrons personal safety, improvements to station and vehicle access, improvements to station and vehicle comfort, improvements to reliability of service, improvements to interconnectivity between modes, increased customer information, and elimination or minimization of transfer time.

- Economic and Land Use Impacts – based on a comparative assessment of the purpose for the proposed land use and current land use, including economic benefits.

- Environmental Justice – based on service and benefits to minority, low income, and transit dependent neighborhoods.

TASK 5: ANALYSIS AND EVALUATION OF OPTIONS

OPERATIONAL ANALYSIS AND PHYSICAL FEASIBILITY

The Evaluation Matrix provided in Appendix C provides an analytical framework for evaluating alternate improvements. As discussed in the previous section, the criteria were drawn from the Program for Mass Transit; however, the definitions of the criteria were modified for this analysis. In general, improvement options were ranked according to the following scale for each of the criteria considered:

+1	positive benefit
1	neither positive or negative
-1	negative impact

The ranks assigned to each alternative were summed to determine if the overall benefits outweighed the negative impacts. The most beneficial alternatives generally had an overall/or summary score of +2 or better. Scores of +1 or below were generally not considered for implementation. The following section is a brief summary of the evaluation matrix.

SHORT-RANGE IMPROVEMENT CONCEPTS

Consolidation of stations and schedule improvements ranked the highest of the proposed short range improvements. Consolidation of stations scored +2 reflecting a positive impact on utilization and positive cost-effectiveness. Although some transit riders may be lost due to the consolidation, the improvement in travel time will benefit others and ridership overall should increase.

Schedule improvements also scored +2. This score reflects a projected increase in ridership since the proposed schedule changes will improve service levels and travel time and is responsive to some of the concerns expressed at the public meetings. The score also reflects positive cost-effectiveness.

Continuously welded track scored +1. Continuously welded track is a safety/reliability-related improvement. Because this improvement is high in cost, and will not directly result in an increase in ridership, it scored -1 in cost-effectiveness, lowering the overall score. Adding continuously welded track will lead to reduced travel times, improved reliability and on-time performance, and most importantly improved safety of commuter rail passengers.

To enhance the potential travel time savings of continuously welded track, signal system upgrades would be required. Signal system upgrades, however, would require a longer implementation period and are therefore further discussed within the medium-range improvement concepts. A decision to begin planning for the implementation and coordination of signal system upgrades is, however, a short-term opportunity to coincide with continuously welded track.

Other improvements such as adding sheltered seating, improving station lighting, providing bicycle storage and offering pass ticket sales scored +1. Each of these improvements scored +1 based on service quality measures. Service quality includes passenger comfort, safety, and interconnectivity of modes. Each of these improvements enhanced one or more aspects of service quality. All stations along the line would benefit from pass ticket sales and sheltered seating, with exception of Fitchburg which offers both amenities and North Leominster which offers sheltered seating only. The South Acton, Littleton, Ayer and Shirley Stations currently lack the provisions for sheltered seating.

The elimination of flag stops scored -1. Although there will be a travel time reduction during off peak times when flag stops typically occur, it is negated by impact on ridership. In addition, eliminating/reducing flag stops had no impact on any of the evaluation criteria with the exception of mobility. Eliminating/reducing flag stops would result in a loss of mobility particularly among passengers west of South Acton, where the distances between stations and gaps in service are large.

MEDIUM-RANGE IMPROVEMENT CONCEPTS

Station improvements were the highest ranked medium-range improvement option. The station improvement program that is taking place at the western end of the line should continue. The specific improvements needed at various stations along the line include expanding parking, platform improvements (to provide handicap access), and better passenger waiting enclosures. Station improvements received a +1 rating in each of the following categories: utilization, air quality, service quality and economic and land use impacts, resulting in an overall score of +4. The Fitchburg and North Leominster Stations are examples or recently improved stations.

Initiation of reverse commute service ranked +2, the second highest ranking. Initiation of reverse commute service refers to outbound morning commuter service and inbound afternoon commuter service at least as far as the South Acton station. Reverse commute service received a +1 rating in mobility and in environmental justice criteria.

Signal system improvement received a +1 ranking, which similar to continuously welded track is a higher priority than the ranking suggests. If the signal system on the line is modernized and upgraded, other improvements such as grade crossing setbacks, real time information, communications systems upgrades, and other infrastructure improvements will also be addressed. Upgrading the signal system will improve service reliability, travel time, operational flexibility, as well as safety of rail passengers. The scoring was negatively impacted by cost effectiveness as the cost of implementation is high. However, utilization and service quality were both +1 ratings.

The Gardner van/bus shuttle scored +1 due to improved accessibility to an area presently unserved by transit. Other infrastructure improvements, which encompass additional rail sidings, automatic interlocking in Ayer, and the addition of a crossover in Shirley, also scored +1 in service quality due to improved reliability in the simultaneous movement of freight and passenger trains.

Resetting grade crossing setbacks and real-time information received neutral or 0 ratings. In both cases, the ratings were adversely impacted by cost-effectiveness. Both improvements do not directly increase ridership or revenues and are costly to implement. These improvements are both worthwhile and may be addressed as part of a larger signal system improvement program though since resetting grade crossings will reduce travel time and installing real time information systems will improve service quality giving passengers accurate information about the status of their trains.

LONG RANGE IMPROVEMENT CONCEPTS

The creation of a regional parking lot and additional peak/off peak service were the highest ranked long-range improvements with scores of +4. The regional parking lot scored points in utilization, air quality, service quality and economic and land use impacts. This parking lot would add needed parking to the Fitchburg Line and add new transit riders. An increase in transit ridership would reduce emissions from personal autos. Vehicle access to the station would be improved thus improving service quality. Finally, this parking facility providing improved transit access to Boston should serve as a catalyst for economic growth and development in the immediate and surrounding area. The cost-effectiveness was considered to be neutral as an increase in ridership and revenues would offset the increase in cost of developing the parking facility.

Additional peak and off peak service scored +4 based on positive ratings for utilization, mobility, air quality and service quality. More service is expected to significantly add to ridership. Additional off peak service will expand options during a time of day when limited service exists. The effect of removing personal autos from the road, even though additional locomotive emissions will be generated should be positive. An increase in service will give existing passengers more choices and, therefore, will have a positive impact on service quality. Cost-effectiveness for additional service was considered to be neutral as the increase in ridership and revenues would offset the increase in operating and capital cost.

Double tracking scored a +1. The benefits of double tracking include reduction in travel time, improved service reliability, and increased operational flexibility that may in turn increase ridership. However, cost-effectiveness was a deterrent because of the high capital cost associated with the installation of additional track miles. Double tracking is not technically a safety issue, but it should be looked upon in a similar way to addition of continuously welded track and signal system improvements. In this analysis, cost effectiveness tended to reduce the ratings for improvements that have major benefits. Double tracking should receive further consideration as an improvement to be implemented.

Increased seating capacity, expansion of reverse commute options and a line extension west of Gardner also scored +1. Increased seating received a +1 rating for service quality, as a result of reduction in overcrowding and passenger comfort. Expanding reverse commute options scored +1 in mobility and environmental justice, however a -1 in cost effectiveness. Expansion of service to the greater Gardner region scored +1 in terms of mobility and economic and land use impacts, but -1 in terms of cost-effectiveness based on the capital cost per passenger. Based on CTPS estimates of 50 additional passengers per day, and a projected capital cost of $50,531,250, the average cost per rider for this project is approximately $1,010,625.

RIDERSHIP ANALYSIS

The following section presents results by line for the Fitchburg Commuter Rail Line, reverse commute opportunities, and new station demand for Wachusett and Gardner Stations. They conclude with an assessment of the results for each improvement timeframe. A complete technical memorandum prepared by CTPS is attached as Appendix D.

The heading on constrained parking demand assumes that the current and future proposed parking limitations due to space availability is a consideration in station selection at all transit stations. The heading for unconstrained parking demand assumes the current and future proposed parking limitations due to space availability is not a factor in transit station selection. Line capacity was not considered in this analysis.

LINE SUMMARY

The following section presents daily boarding estimates for three forecast years: 2004, 2010, and 2025 from the CTPS regional travel demand model. The numbers presented reflect the Fitchburg Commuter Rail Line ridership by year, before and after improvements in the no-build and build scenarios.

Ridership Assuming Constrained Parking Demand

The short-range improvements assumed for 2004 increase daily total boardings by 300. Just under half of these, -120- occur in the inbound direction in the AM peak period. The medium-range improvements assumed for 2010 increase daily total boardings by 400. One hundred and twenty of these occur in the inbound direction during the AM peak period. The long-range improvements assumed for 2025 increase daily total boardings by 780. About a third of these, -260- occur in the inbound direction of the AM peak period.

Ridership Assuming Unconstrained Parking Demand

The short-range improvements assumed for 2004 increase daily total boardings by 220. Just under half of these, -80- occur in the inbound direction for the AM peak period. The medium-range improvements assumed for 2010 increase daily inbound and outbound boardings by 470. One hundred and sixty of these occur in the inbound direction during the AM peak period. The long-range improvements assumed for 2025 increase daily inbound and outbound boardings by 900. Just under a third of these, -280- occur in the inbound direction of the AM peak period.

REVERSE COMMUTE

Reverse commutes—work trips that flow in the opposite direction of the traditional downtown-oriented radial commute—have increased steadily over the past two decades and continue to capture a growing share of the total journey-to-work "travel pie." The following results show how the Fitchburg Commuter Rail Line will be utilized for reverse commuting after it has undergone improvements.

Ridership Assuming Constrained Parking Demand

Assuming constrained parking, the Fitchburg Commuter Rail Line in 2004 has 320 boardings occurring in the reverse peak direction for the AM peak period. This includes boardings made for work as well as other purposes such as school. The short-range improvements help increase the reverse commute slightly to 340 boardings. In 2010, the reverse commute in the AM peak period on the commuter rail increases to 410 boardings. The improvements in commuter rail service produce fewer than 10 new boardings. In 2025, the reverse commute in the AM peak period increases to 460 boardings. The improvements in commuter rail service produce 20 new boardings.

Ridership Assuming Unconstrained Parking Demand

With an unconstrained parking situation, the Fitchburg Commuter Rail Line in 2004 has 400 boardings occurring in the reverse peak direction, for the AM peak period. The short-range improvements help increases the reverse commute slightly to 410 boardings. In 2010, the reverse commute in the AM peak period on the commuter rail increases to 510. The improvements in commuter rail service produce 30 new boardings. In 2025 the reverse commute in the AM peak period on the commuter rail increases to 640 boardings. The improvements to the commuter rail generate under 20 new trips.

NEW STATIONS

The long-range improvements using 2025 as a horizon year include extending the Fitchburg commuter rail to Gardner via Wachusett Station. The following section describes the ridership results associated with adding these stations.

Wachusett Station

In the constrained parking situation, Wachusett Station produces 160 boardings daily. The majority of these, 90 occur in the AM peak period. Most people drive to this station resulting in over 100 drive access trips. It has a small walk market, 30 people, and about 30 drop-offs. The unconstrained condition attracts 190 boardings daily with 110 occurring in the AM peak period. The increase in boardings can be attributed to the unlimited parking assumption.

Gardner Station

In the constrained parking situation, Gardner Station produces 60 boardings daily. The majority of these, 50 occur in the AM peak period. The mode of access is evenly split between drive and walk modes, with a handful of drop-offs. The unconstrained condition is almost identical to the constrained condition with regards to the number of boardings and mode of access.

ASSESSMENT

Line Summary

The short-range improvements had varying degrees of impact on the travel demand estimates. Consolidating the stations in Weston and Belmont saved about a minute of run-time in both inbound and outbound directions. Increasing speeds also added a minute of run timesavings. The combined run-time improvements probably contributed to less than half of the ridership increases. More trains in the peak and off-peak periods reduces the headway and results in more train options for commuters while also reducing wait time as perceived by the model. A majority of the new ridership can be attributed to the third improvement.

The difference in boardings between the constrained and unconstrained parking demand may seem counterintuitive at first but the unconstrained parking demand assumption opens up parking opportunities at Alewife Station on the Red Line which siphons demand from the Fitchburg Line, especially after three stations are closed in Weston and Belmont.

The medium-range improvements expanded on the short-range improvements, expanded parking options, and adjusted the timing of reverse commute trains so they arrive in Fitchburg earlier. The majority of the increase was due to the improvements considered in the short-range improvements with the difference being due to the availability of parking Regional Station 1 in the constrained parking scenario. The scheduling of reverse commute trains to arrive in Fitchburg earlier make little difference.

The long-range improvements encompasses all of the improvements considered in the medium-range scenario, as well as the addition of two new stations, another regional station, and a slight improvement in runtimes due to double tracking. Adding the new stations would be responsible for more than half of the new boardings. It is difficult to attribute the impact the previous improvements have on the overall ridership increase and it is unlikely the new run-time improvements are significant enough to have an effect on the results.

Reverse Commute

In 2000, the Rte 2/Fitchburg Commuter Rail corridor between Athol and Watertown contained over 135,000 work trips, reverse commutes made up over 19 percent of these trips. Only about 250 of these trips were made using the commuter rail. The model shows that adjusting arrival times has a minimal effect in attracting new riders. Assuming that the runtime has been minimized to the best extent possible, the only other option is to improve the headways. However, in light of research done by Tom Humphrey of CTPS in 2001, better headways still only attract a small number of new riders.

For almost all commuters with autos available, driving from a home in Boston to a suburban work location would be faster than taking commuter rail. Driving offers a one-vehicle ride from origin to destination, with full flexibility in departure times. Reverse-commuters travel in the opposite direction from peak highway traffic, and most have ample free parking provided at their work locations. Transit riders do have the ability to read or work while traveling, which auto drivers do not, but this advantage for transit is negated to the extent that longer travel times reduce the time that could otherwise be spent productively at home or at the work location. For these reasons, actual diversions of auto users to commuter rail reverse commuting service are likely to be much lower than the estimate above (Humphrey, 2001).

New Stations

The demand at the new stations is partially attributed to diversions from the Fitchburg and North Leominister Stations, along with people switching from the auto mode and to commuter rail. Given the number of people, who are projected to live in this area in 2025 and work in the core area, less than 600, the market for transit is limited. Before improvements are made, about 100 of these 600 would take the Fitchburg Commuter Rail Line. After improvements, approximately 250 Boston bound trips take the commuter rail. An analysis of unconstrained and constrained parking assumptions shows that this isn't a significant factor in determining the demand for these stations.

CAPITAL COSTS

A preliminary cost estimate of capital improvements is detailed in Appendix E. As shown in Appendix E, improvements to the Fitchburg line are estimated at approximately $55 million. In addition, $39 million in current dollars would ultimately be needed in State and Federal funding to extend the service to Wachusett Station. An additional $51 million dollars would ultimately be needed to extend service to Gardner. An estimated $145 million dollars would be required in State and Federal funding to complete all recommended improvements. Note, these estimates were created in 2004 and will increase approximately 5% per year.

RECOMMENDATIONS

The following section provides a summary of the three recommended improvement packages suggested for implementation within the short-range (0-5 years), medium-range (5-10 years), and the long-range (10+ years). These packages are recommended based on the matrix evaluation of the improvement concepts and constraints of the Fitchburg Line in coordination with the CTPS ridership report.

Short-Range Recommendations

The following concepts for improvement are considered the best alternatives for implementation within the next five years: consolidate stations, schedule improvements, addition of continuously welded track, and initiate design of signal upgrades. As previously mentioned, continuously welded rail is the first step in improving travel times by making it possible to upgrade signal systems and have reduced delays and increased speeds.

There are opportunities to make minor scheduling changes without additional rolling stock or train crews. These include extending the 3:00 PM outbound train from South Acton to Fitchburg. This train could then be run inbound from Fitchburg at 5:00 PM, arriving at North Station at 6:25 PM in time for evening events at the Fleet Center or other Boston destinations. The 4:50 PM outbound train could end at South Acton and return to North Station at 6:00 PM. Since the new express 4:40 PM train carries most of the passengers to South Acton and makes all station stops to Fitchburg, the portion of the 4:50 PM from South Acton to Fitchburg is redundant. The 4:40 PM train could end in Fitchburg, which presently turns into the 6:12 PM inbound, and could be eliminated and replaced by the proposed 5:00 PM inbound.

In addition, there are opportunities to operate new trains to supplement both the morning and evening commuter service. These include the inbound #402, which could depart Fitchburg at 5:05 AM and arrive at North Station at 6:30 AM and the inbound #452, which could depart South Acton at 7:40 AM and arrive at North Station at 8:34 AM. Opportunities to expand the outbound service include a proposed #451 train, which would depart North Station at 6:40 AM and arrive at the South Acton Station at 7:30 AM, and a #427 train, which would depart North Station at 3:45 PM and arrive at Fitchburg at 5:11 PM.

Medium-Range Recommendations

Station improvements and initiation of reverse commute service were the strongest medium-range improvement concepts. With additional weighting placed on safety considerations and reliability, upgrading the signal system would also be included for implementation within five to ten years. The initiation of reverse commute service would be a result of the additional service proposed in the short-term recommendations. Utilization levels of the reverse commute service will need continuous monitoring to determine effectiveness.

Long-Range Recommendations

The creation of a regional parking facility and additional peak/off peak service were the strongest long-range improvement concepts suggested for improvement. As previously discussed, double tracking should also be considered as it offers many benefits, despite the cost of implementation. The extension of service to the greater Gardner region should also be developed as a long-range service improvement.

TASK 6: FINAL REPORT

Based on the analysis presented within the previous sections, improvement packages for the Fitchburg Line have been defined for implementation in the short-range, medium-range and long-range. Each of the improvement packages includes three elements. The short-range (implemented within the next five years) improvement package includes consolidation of stations, schedule improvements and addition of continuously welded track/design of signal system upgrades. The medium-range (implemented within 5 – 10 years) improvement package includes station improvements, implementation of reverse commute options and signal system improvements. Finally, the long-range (implementation expected to take 10 or more years) improvement package includes the creation of a regional parking facility, additional peak/off peak service, double tracking and extension of service to a proposed Wachusett Station and/or Gardner.